Technically Watches

Antique Watch Restoration, Part CXVII

By Archie B. Perkins, CMW, FNAWCC, MBHI

Characteristics of Hairsprings

A hairspring is made from material that has a rectangular cross section. The strength of a hairspring is dependent upon its thickness, width, and length. Figure 1 is used to illustrate this characteristic. View A shows a section of hairspring with a given width, thickness, and length. If we change any one of these dimensions, we will be changing the strength of the section of hairspring.

View B, Figure 1 shows a section of hairspring that has a width which is two times as wide as the one shown in View A. When this is done, keeping the thickness and length the same, the spring will be two times as strong. In other words, to double the width, we double the strength if the thickness and length remain the same. When we make the width one-half as wide, then the spring will be one-half as strong if the thickness and length are unchanged.

If the thickness of a spring is changed, the strength of the spring is affected the most. Changing the thickness changes the strength as the cube of the thickness (T^3). If we double the thickness without changing the width or length, the spring will be eight times stronger. (See View C, Figure 1.) The following is an example. If we take a hairspring that is .06 mm thick and cube this thickness, .06 x .06 x .06 equals .000216. Now, if we double the thickness to .12 and cube this .12 x .12 x .12, we would have .001728.

If we divide the last number by the first number, we will have $\frac{.001728}{.000216} = 8$, or 8 times stronger. If a spring is made one-half as thick, it will be one-eighth as strong.

View D, Figure 1 shows a section of spring that is twice as long as the spring in View A. When the length only is changed, the strength varies in inverse proportion. As the length is doubled, the spring will be one-half as strong. When the spring is made one-half as long, it will be twice as strong.

Calculating the Length of a Spiral Spring

Figure 2 is used to show how a spiral spring is calculated to determine its length. The formula used to determine the length of a spiral spring is:

$$L = \pi \times N \times \left(\frac{D + d}{2}\right)$$ when:

L = Length of spiral
N = Number of coils
D = Diameter of spring
d = Diameter of inside coil
π = Pi or 3.1416

To use the formula to determine the length of a given spiral spring, the following information is needed: number of coils - 9.5, diameter of spring - 12.00 mm, and di-

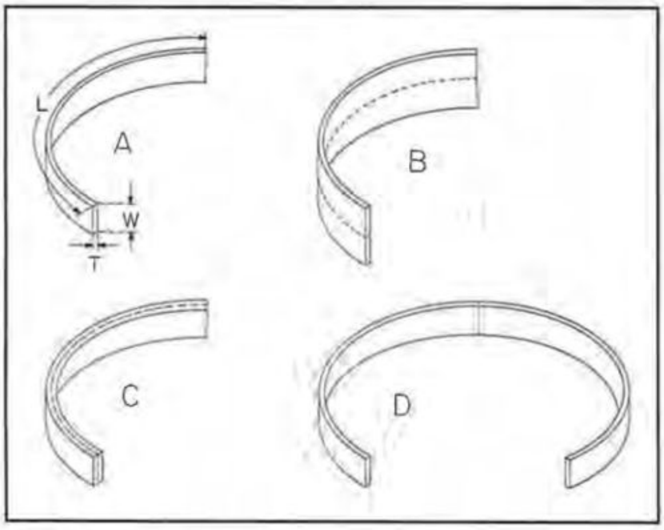


Figure 1.

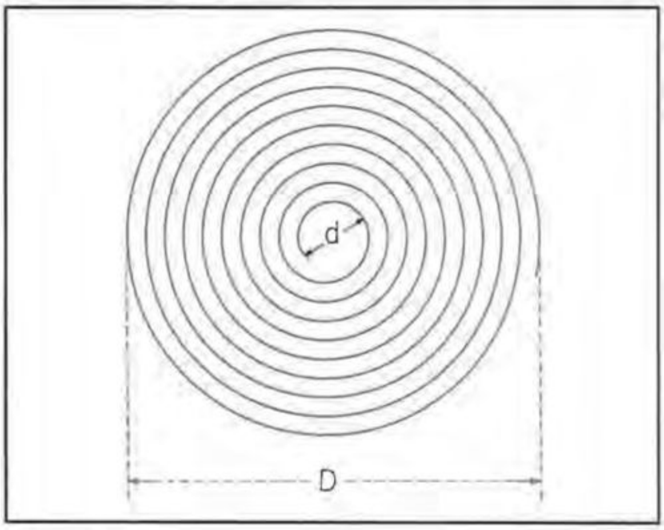


Figure 2.

ameter of inside coil - 3.00 mm. Thus,

$$L = \pi \times N \times \left(\frac{D + d}{2}\right)$$

$$L = \pi \times N \times 7.5$$

$$L = 3.1416 \times 9.5 \times 7.5 = 223.839 \text{ mm.}$$

Any fraction of a coil, such as the tongue, is added to this amount to have the total length.

Truing Hairsprings in the Round

A hairspring is out of true in the round when the spaces between coils are not equal at one point or another. The bend causing the condition is usually found at 90° from the point where the spacing is the closest or the widest. To locate the bend, follow the correct coil spacing inside where the distortion occurs and follow these spacings outwardly until the space starts closing up or opening up. The bend is at this point and exactly 90° from where the space is off the most. It is very important to locate the bend exactly and straighten the spring at the exact point where the bend is; otherwise, there will be two bends instead of the original one bend. In other words, the spring will be in worse shape and need two corrections instead of one. It would be better to take ten minutes to locate the exact bend point and ten seconds to correct the bend than to take ten seconds to locate the bend and ten minutes to correct the bend. The correction should be made with the least possible amount of bending. Spring material becomes damaged very quickly with unnecessary bending.

To true hairsprings, a piece of plate glass that has been frosted on one side is used as a rest for the spring while it is being straightened. The spring is rested on the smooth side of the glass. The frosting on the lower side of the glass helps to cut down on the shadows of the spring. The glass can be frosted by rubbing two pieces of glass together with wet, fine carborundum powder between them.

Another method of supporting the spring is to use a flat glass in a watch or clock bezel. In this case, the glass does not need to be frosted. The bezel raises the glass far enough off of the bench that the shadow of the hairspring is not seen.

The tweezer used to hold the hairspring while the bend is corrected should not have sharp corners on the inside of the jaws. The sharp edges should be removed and slightly rounded. Figure 3 shows a bent hairspring on a frosted glass and the method used to correct the error in the spring. Two 90° lines have been made on the frosted side of the glass with a pencil to be used for locating the exact point of the bend in the spring. The spring is placed on the glass and centered over the center of the two right angle lines. Then, the spring is turned until one line is centered with the closest or widest point of the spring. In this particular case, the line goes through the closest point which is at "a." The bend will be 90° back of this closest point or at "b." The hairspring should always be placed on the glass as shown so the operator must reach across the body of the hairspring to grasp the bend in the hairspring.

To straighten this hairspring, it is held with the tweezer close to the bend at "c," then a needle or a hairspring pin is used on the inside of the coil as shown and pulled outward in the direction of the arrow until the coil is positioned over the broken line. This will place the coil at a normal spacing from the next coil. The coil will need to be moved beyond where it should be in order for it to come back to the proper position. It is a good idea to take an old spring to practice the bending. In other words, bend the spring out of true and then straighten it just to get the feel

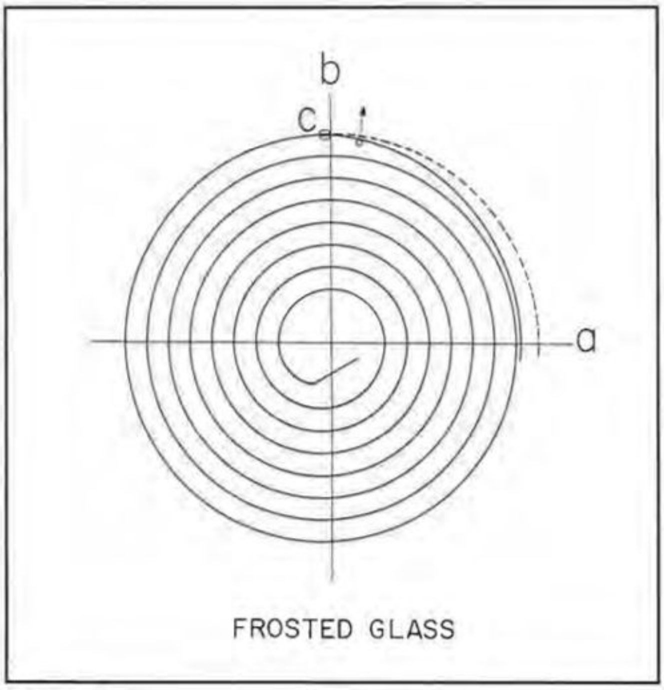


Figure 3.

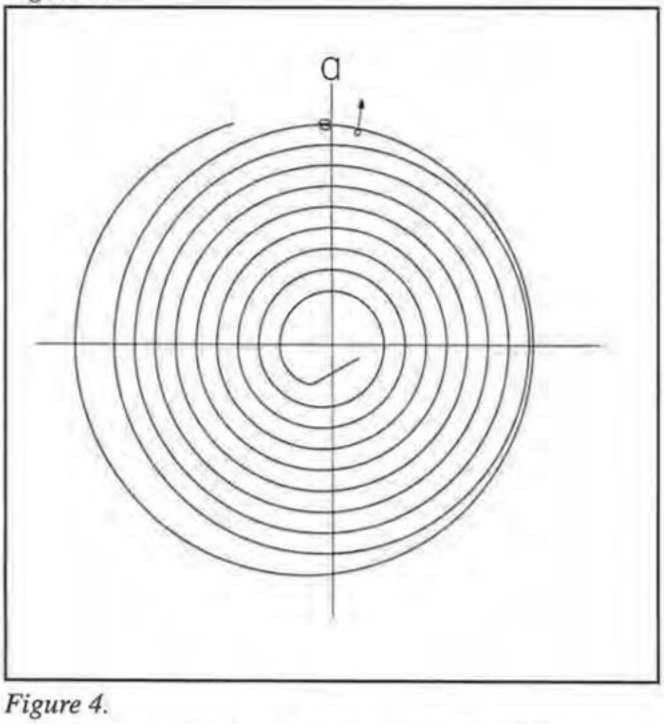
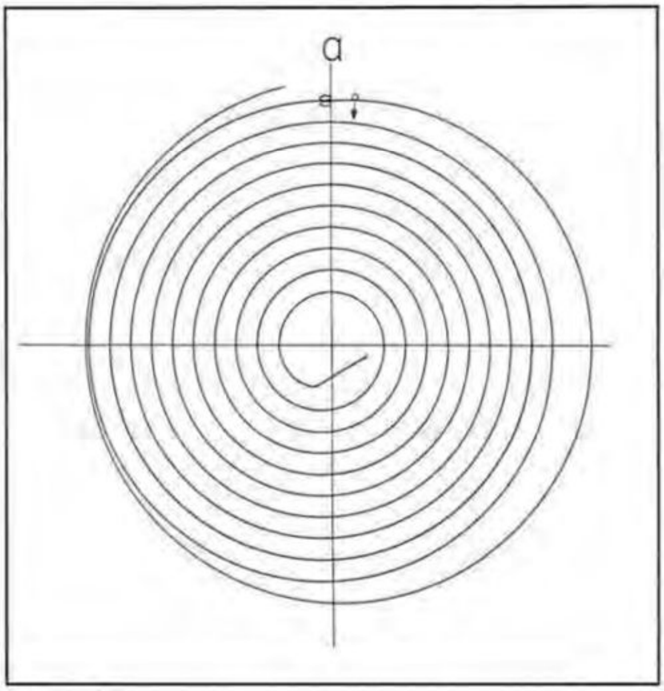


Figure 4.

and nature of the work before actually doing controlled corrections.

When straightening hairsprings, how close the needle is away from the holding tweezer depends on how sharp the bend is in the hairspring. If the bend is sharp, the needle would be placed closer to the holding tweezer in order to correct the sharp bend. If the needle is used too far from the holding tweezer, a second bend is likely to occur without correcting the first bend. The needle should be held in an upright position so it is flat against the coil; otherwise, the coil may be thrown out of flat when the spring is trued. Care also must be used so the spring will not be pressed too hard against the glass with the tweezers as this could throw the spring out of true in the flat.

Figure 4 shows an out-of-true hairspring. Note that the spring has a close point as well as a wide point between the coils. When the hairspring is placed on the glass and centered with the cross so the horizontal line goes through the center of the wide and close space, it is determined that the bend is at point "a." The tweezer is used to grasp the spring at point "a" as shown, then the needle is used to push out on the coil near the tweezer to correct the close spacing. At the same time, the wide space will also be corrected if there are no other bends in the spring.



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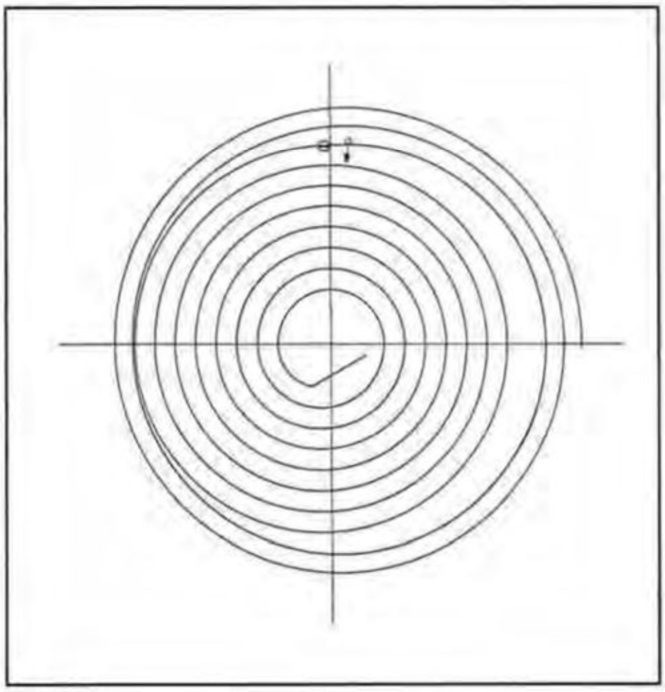

Figure 7.

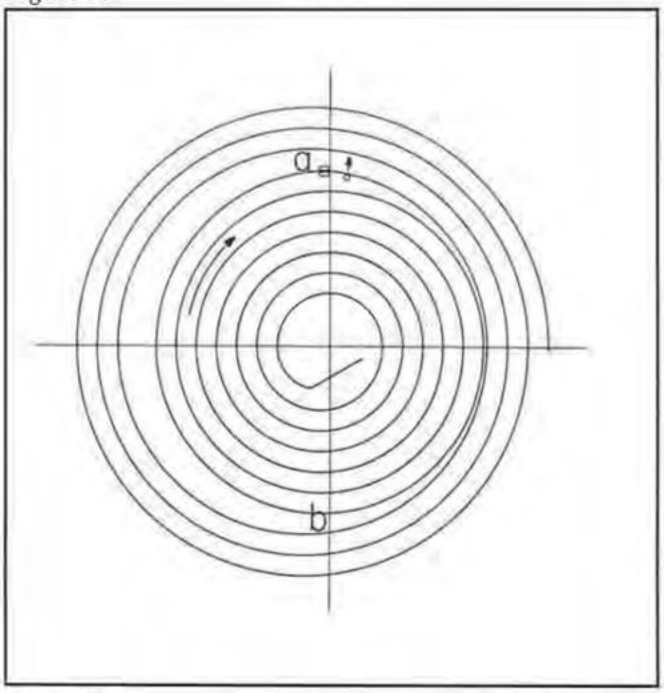

Figure 6.

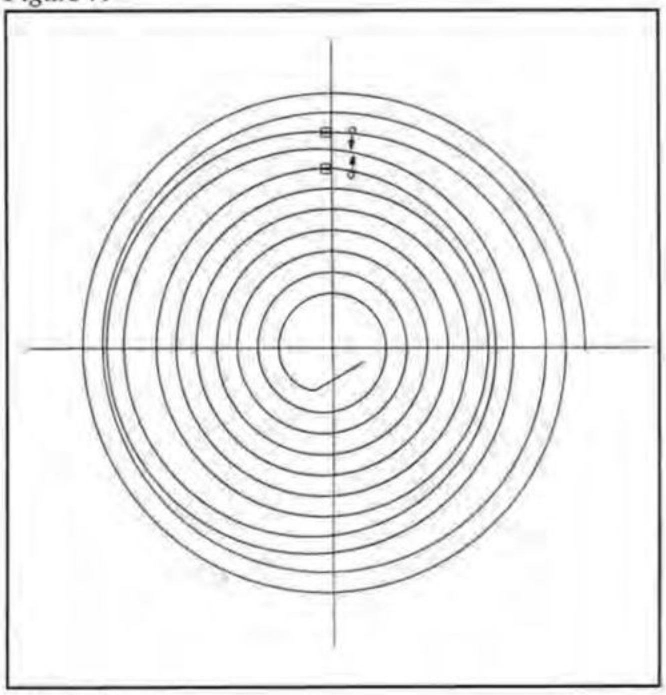

Figure 8.

Correcting the one bend will correct the coil for a complete turn if there are no other bends in that coil.

Figure 5 shows a hairspring that is bent outward at point "a," which is just the opposite to the example shown in Figure 4. In this case, the coil is held at point "a" and pushed in with the needle, as shown, to close up the wide space which will also open up the close space on the opposite side.

Figure 6 shows a bent hairspring in which the bend is on the fourth coil in the body of the spring. At a glance, it could appear that the bend could be at point "a" or point "b." The only way to really tell where the bend is located is to start inside the spring where the coil spaces are normal and trace the spaces outwardly in the direction of the arrow. When a point is reached where the space starts opening or closing as in this case, the bend will be located at point "a." To correct the hairspring, it is held with the tweezer at the bend and the coil is pulled outward to open up the close space and, at the same time, the wide space will be reduced.

Figure 7 shows a condition that is just the opposite to that in Figure 6. The bend is located, then the spring is held with the tweezer up next to the bend (not on the bend) while the needle is used to push the coil inward to close up the wide space and open up the close space.

Figure 8 shows a hairspring that has two bends. The bends are on the third and fifth coils from the outside of the spring. Since both bends are closer to the outside coil of the hairspring, it is recommended that the inside bend be corrected first, then the outside bend is corrected. In other words, we would work from the inside of the spring toward the outside. If the bends should be nearer the center of the spring, we would work from the outside of the spring toward the center of the spring.

The inside bend is corrected by grasping the coil with the tweezers next to the bend and pulling out on the coil with the needle until the close and wide spaces are equal. The second bend is corrected by holding the coil with the tweezers next to the bend and pushing in on the coil with the needle to equalize the wide and close spaces.

Truing Hairsprings in the Flat

When truing hairsprings in the flat, two tweezers are needed. It is a good idea to have two tweezers of the same style and shape. The points should be the same distance apart and require the same pressure to close the points. A light touch is needed for truing hairsprings. This is gotten by having the points of the tweezers fairly close together, not more than 2.00 mm apart.

Figure 9 shows three different styles of tweezers that can be used for truing hairsprings in the flat. View A shows two hairspring tweezers first developed by the Elgin Watch Company and later made by Dumont. These tweezers have strong points which are shaped so when the tweezer is being used on a hairspring and held normally in the hands, the side of the point is vertical and at right angles to the coil of the hairspring. This causes the bend to be made square with the coil. If the bend is made at an angle to the coil, the coil is likely to become twisted where it is bent. This would cause the coils to go askew.

View B, Figure 9 shows two tweezers that were made from regular tweezers by reshaping the points. This shape of tweezer cannot be bought like this but must be shaped this way by the

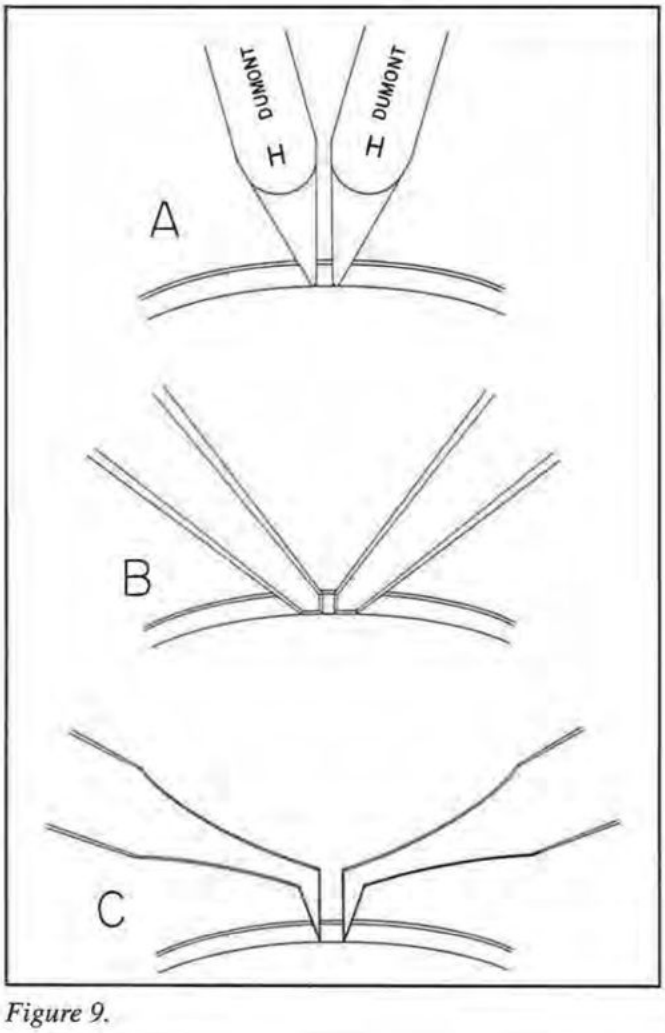

Figure 9.

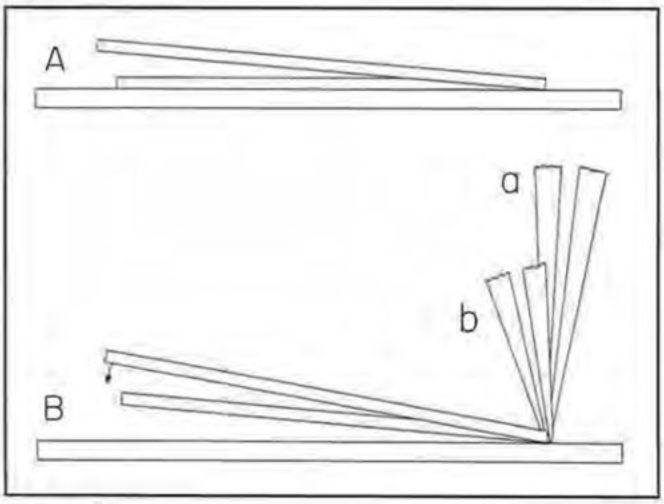

Figure 10.

watchmaker. This shape of tweezer allows the coil to be bent at right angles to the length of the coil.

View C, Figure 9 shows a special shaped tweezer that can be bought in Dumont quality. Its style is #6. Some watchmakers prefer this style of tweezer for hairspring work.

Figure 10 shows how a hairspring is trued in the flat. View A shows an out-of-flat hairspring resting on the hairspring glass. The outside coil is higher than the body of the spring. The bend will be 180° from the point where the high coil is the greatest distance above the body of the spring. The hairspring is centered on the intersection of the lines on the glass with one of the lines going through the bend point.

View B, Figure 10 shows the spring being trued. To true the spring, grasp the bent coil next to the bend with tweezer "a." Then, tilt the body of the spring slightly off of the glass as shown. This is done to allow the high coil to be bent down enough to level the spring without forcing the high coil against the glass and causing the coil to go askew. After the hairspring has been tilted off of the glass, then tweezer "b" is used near tweezer "a" to pinch the high coil down level with the body of the spring, keeping the coil centered with the body of the spring all at the same time. This method is used regardless of where the bend is in the body of the spring.

Correcting an Edgewise Bend

There are times when a coil gets an edgewise bend as shown in Figure 11. This type of bend is removed on a piece of soft wood such as an emery stick handle. To remove the bend in the hairspring, it is held on the bend with a sharp, pointed tweezer and pressed against the wood as the tweezer point goes into the wood. This must be done with caution to avoid overdoing the correction and damaging the spring. After the edgewise bend has been removed, the spring is leveled by the method shown in Figure 10.

Leveling a Spring That Has Been Stretched

There are times then the watchmaker is confronted with a hairspring that is cupped out of flat because of an accident. This usually occurs when the balance cock is removed from the watch while the hairspring is still attached to the cock. The balance staff pivot gets caught in the lower hole jewel or sticks in the hole without the watchmaker knowing that it has. The watchmaker lifts the balance cock too far and stretches the hairspring, leaving it cupped.

Figure 12 shows how the hairspring can be held on a broach while the tweezer is used to pull the hairspring away from the cupped position to stretch the spring to remove the cupped condition. This manipulation should be done with caution to avoid overdoing the process.

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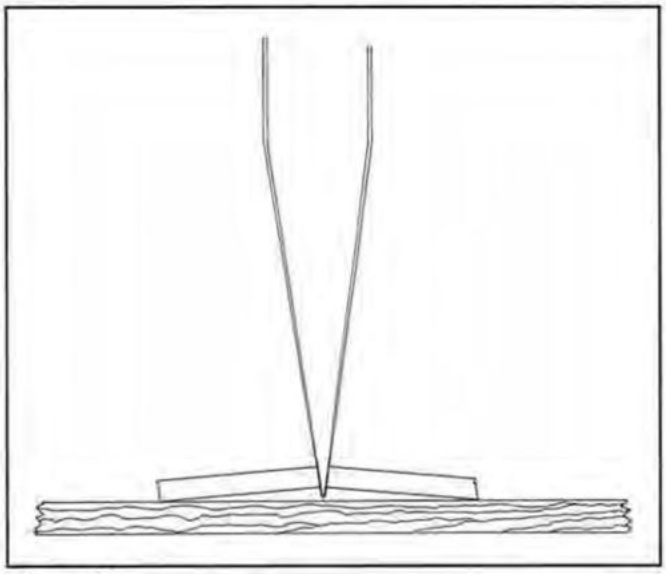


Figure 11.

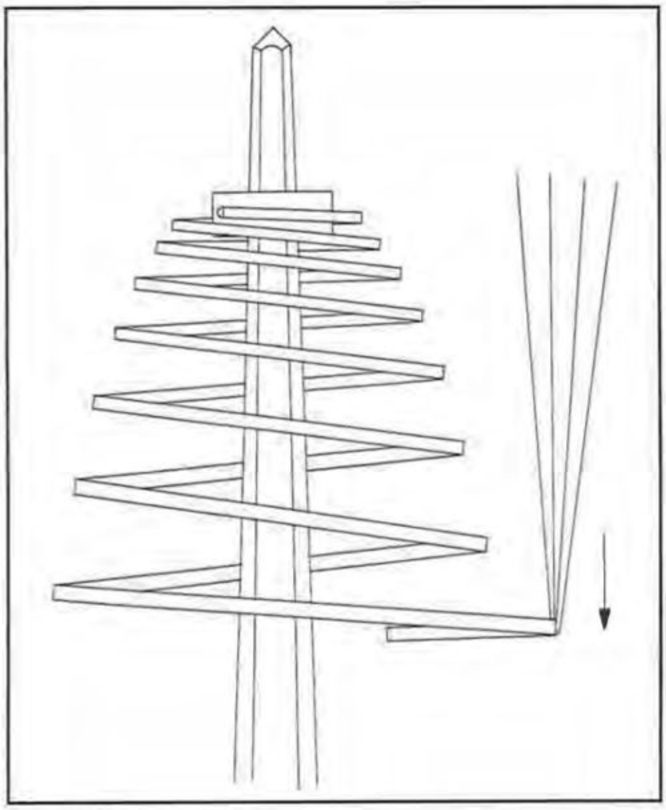


Figure 12.

Technically Watches

Antique Watch Restoration, Part CXVIII

Colleting Hairsprings

By Archie B. Perkins, CMW, FNAWCC, MBHI

When colleting hairsprings, the watchmaker should have a good understanding of the design of a hairspring collet. Figure 1 is used to show the general design of the top and bottom of a hairspring collet. View A shows the top of a collet. The top of a collet is usually finished better than the bottom side. This is mainly for the sake of appearance. The top is usually flat or beveled slightly toward the center hole. The outside corner of the top is beveled slightly. Sometimes the corner of the hole is also beveled slightly, as shown, but not always.

View B, Figure 1 shows the bottom side of the hairspring collet. The outside corner of the bottom is usually beveled more than the top corner. This is to allow a tool to be more easily inserted between the balance arm and the bottom of the collet for removing the collet. The bevel that extends into the hole on the bottom of the collet is usually very steep into the hole. The purpose of this bevel is to allow the collet to start easily onto the shoulder of the balance staff.

Figure 2 shows the relationship between the slot in the collet and the cross hole into which the end of the hairspring is pinned. View A shows a collet in which the slot has been sawed parallel to the cross hole in the collet. This is considered a good collet design. View B, Figure 2 shows a collet that has the slot sawed at a 90° angle to the cross hole. This design has undesirable features. The cross hole goes through the flex point of the collet. When removing the collet with a wedge-shaped tool in the slot of the collet, the pinning of the spring in the cross hole is likely to be disturbed. Also, if the collet is thin and delicate with a large cross hole, the collet will break or become fatigued at the cross hole during removal.

A third style of hairspring collet is one which has the slot sawed at a 45° angle to the cross hole. This is a compromise between the two other styles of collets.

Figure 3 shows two different hairspring collets. The collet that is shown in View A has the cross for the hairspring drilled near the top of the collet. This collet is used for a flat hairspring. The cross hole location more nearly divides the space between the balance wheel arm and the under side of the balance cock. Note: Sometimes the cross hole is drilled in the center of the height of the collet for a flat hairspring.

The collet shown in View B, Figure 3 has the cross hole drilled near the bottom of the collet. This collet is used for an overcoiled hairspring. The low cross hole position allows space for the overcoil between the body of the hairspring and the under side of the balance cock.

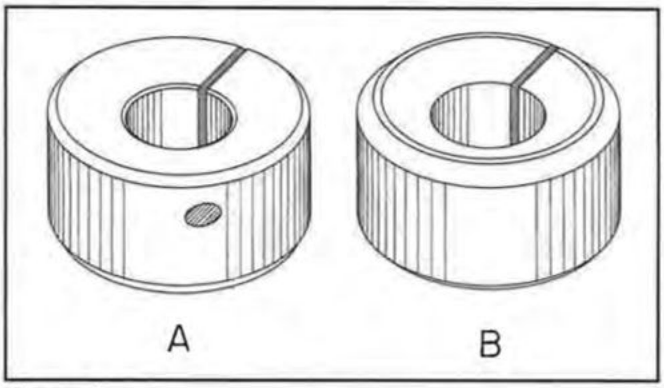
Making a Hairspring Collet

When colleting a hairspring, it is best to use the old original hairspring collet whenever possible. If the original collet is damaged, then a new genuine collet should be bought to be used if obtainable. If a new collet is needed and cannot be obtained, one should be made.

Figure 4 shows the first steps in making a new hairspring collet. The new collet is made from hard brass turning rod. The diameter of the rod should be large enough to allow for stability when drilling the cross hole and sawing the slot. The rod is chucked true in the lathe headstock. Then, the rod is turned down in diameter at its end so it is slightly larger than the finished collet is to be. Next, a center is made in the end of the rod for drilling the center hole. Then, the center hole is drilled slightly smaller than the shoulder on the balance staff where the collet will be used. After this, the end of the rod is shaped for the top of the collet. This consists of facing the end of the rod and beveling the corner. Next, the length of the collet is determined, and a parting tool is used to cut a groove to lay off the collet length.

After this, the cross hole is drilled for the hairspring. When this is done, the drill is used in the milling attachment set on top of the slide rest. The spindle of the attachment is set in a vertical position. The drill is chucked true in the spindle of the milling attachment. A 360° index plate is used on the spindle of the lathe so the spindle can be indexed a degree at a time. After this, the point of the drill is centered with the lathe center and located at the proper place on the collet for starting the cross hole. The hole is drilled straight toward the center of the collet to a depth that is just deep enough to hold the drill point in position for drilling the cross hole after the collet has been repositioned for drilling the cross hole.

Figure 5 shows the collet after it has been indexed into position for drilling the cross hole. The collet is indexed 40° counterclockwise to position it for drilling the cross hole. The drill has also been moved over into position for drilling the cross hole. After the cross hole has been drilled, a graver is used to turn the collet to size and smooth up its outside surface. This will also remove burrs created when the cross hole was drilled. Next, the slot is sawed.



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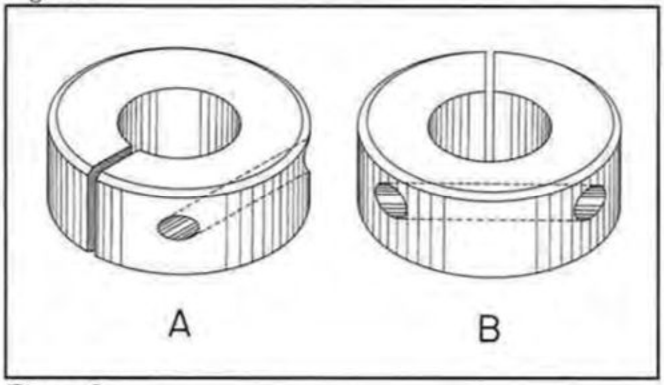

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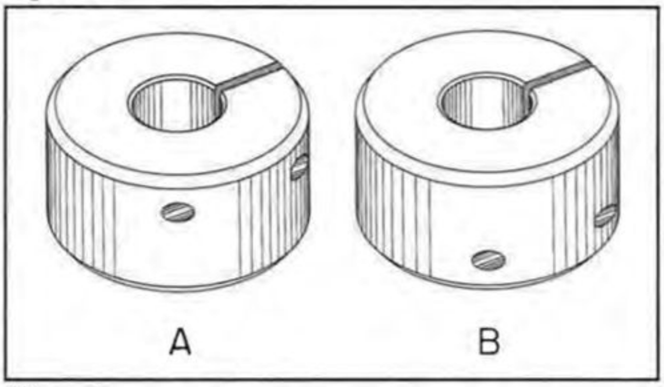

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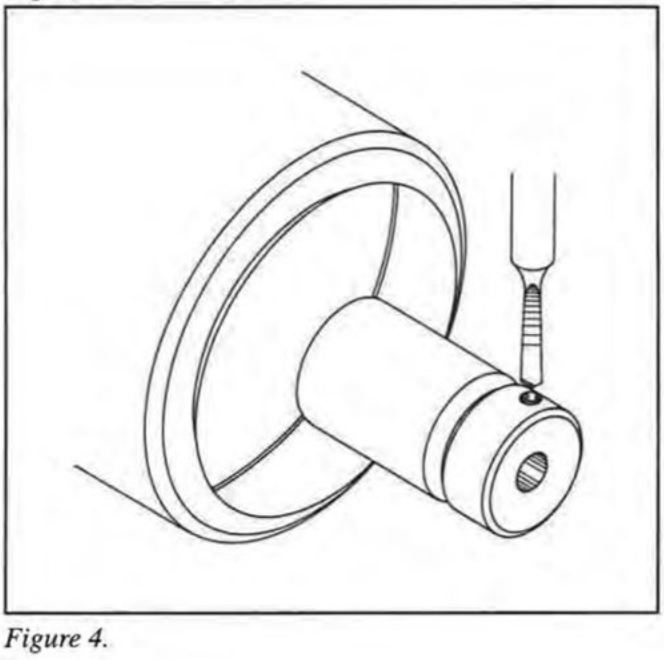

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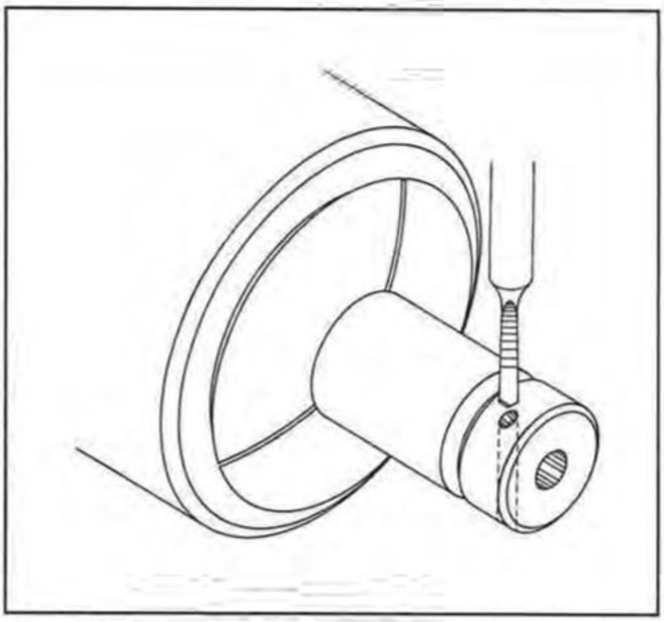

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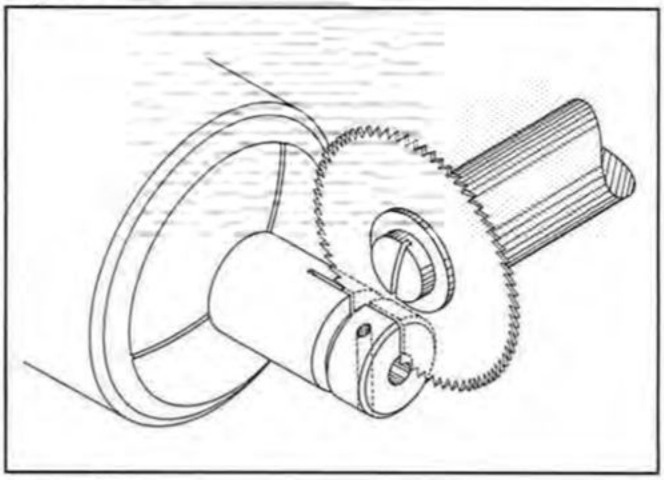

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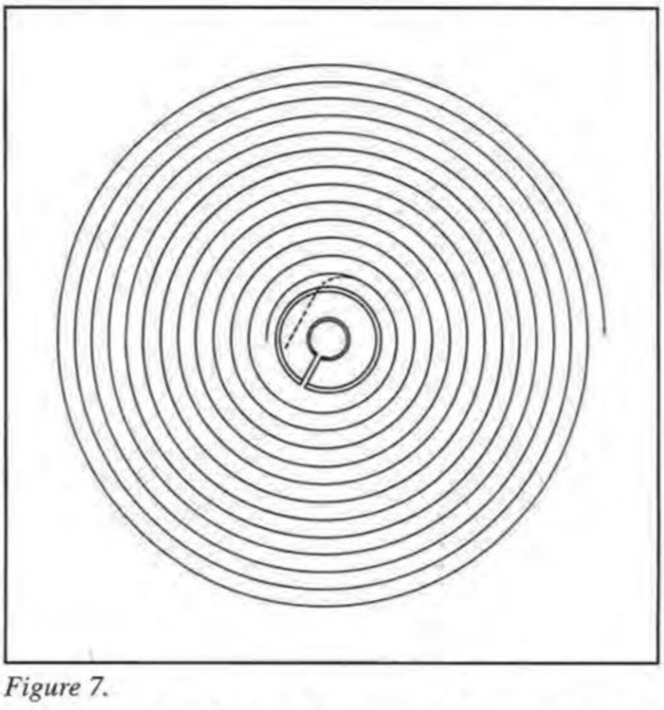
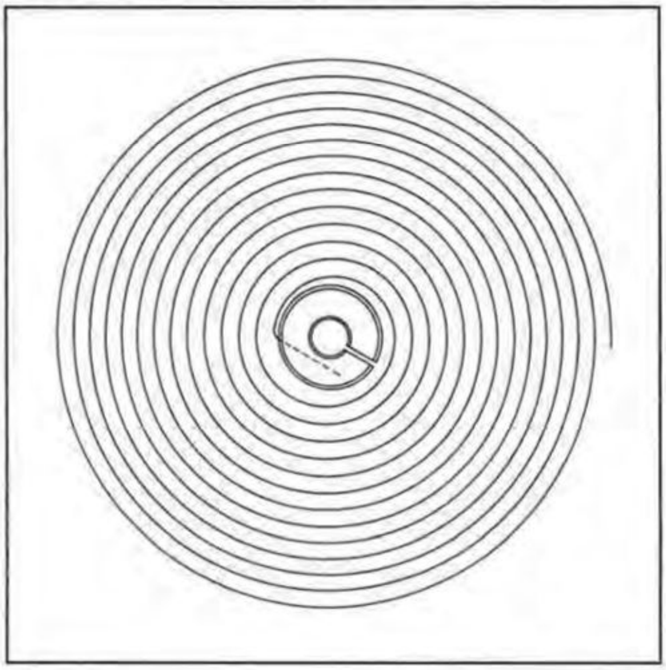


Figure 7.

Sawing the Slot in the Collet

Figure 6 shows the slot being sawed in the collet. To saw the slot, the milling attachment is used with its spindle set in a horizontal position. The saw is held on an arbor chuck and fastened in the spindle of the milling attachment. The edge of the saw is centered with the lathe center. The thickness of the saw should equal approximately one-fifteenth of the hairspring collet diameter (diameter of collet divided by 15). After the slot has been sawed, the collet is cut off of the rod with a cut-off tool or jewelers saw. Next, the collet is chucked in a wire chuck or a step chuck while the bottom of the collet is shaped and finished. If collets are being mass produced, they could be frictioned onto a post in the end of a rod for sawing the slot after the cross hole is drilled.



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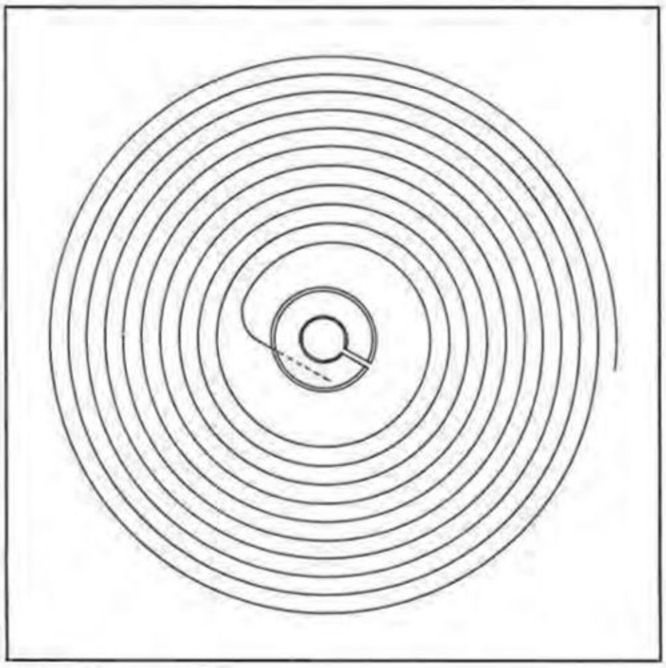
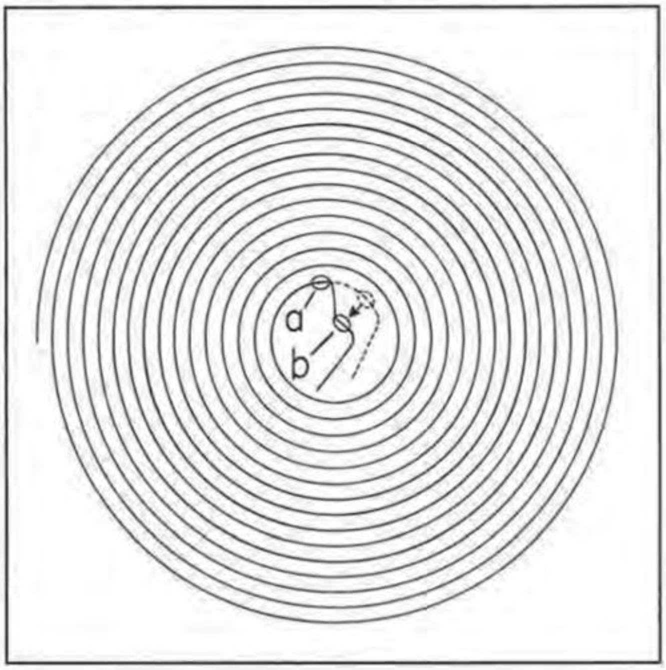


Figure 9.

Breaking out the Center of the Spring for the Collet

When colleting a hairspring, there is almost always the need to break out some of the center of the hairspring to fit the collet. Figure 7 shows a hairspring that has had the proper amount of hairspring broken away to fit the collet. With the collet centered in the spiral, the spring should be broken off at a point where there will be about half of a normal space between the end of the spring and the edge of the collet. The bend to form the tongue of the spring should start about one-fourth turn back of the end of the spring. The tongue after it is formed is shown in broken line in the illustration. At the point where the tongue starts to leave the body of the hairspring, the space between the first coil and the collet should be equal to the distance between two coils. There



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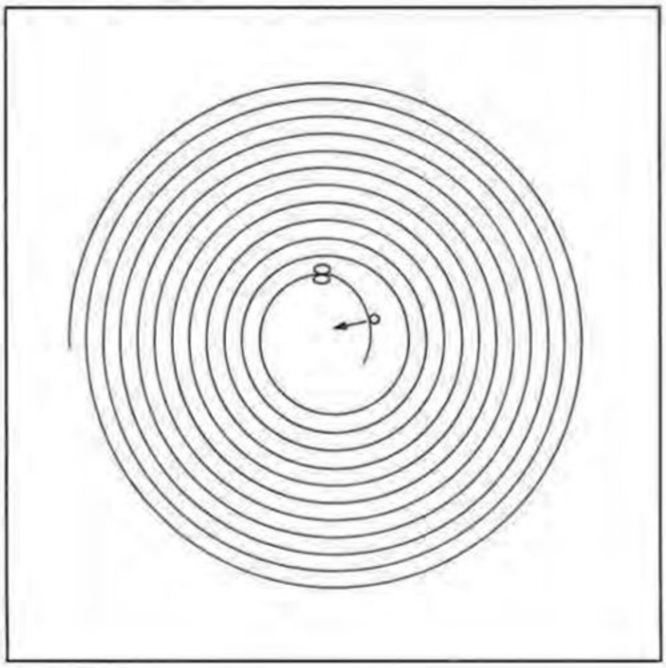

Figure 11.

are exceptions to this rule. If the coils of the hairspring are extremely close together, more space should be allowed between the collet and the first coil than the distance between two coils. If the space between coils is wide, the space between the collet and the first coil should be less than the distance between the coils.

Space not Large Enough for the Collet

Figure 8 shows an undesirable condition where not enough spring has been broken out to allow for the collet. This condition sometimes allows the first coil to touch the collet as the spring contracts during vibration. This causes the watch to run faster when the spring touches the collet as this would shorten the active length of the hairspring.

Space too Large for the Collet

Figure 9 shows a case where too much of the inner coil has been broken away for the collet. This causes a condition where the timing point of the spring will be moved farther out on the coils of the spring. This may cause the spring to be too large in diameter for the watch, especially if the watch requires a flat hairspring. Also, when too much of the hairspring is broken out for the collet, it becomes more difficult to true the spring around the collet due to the wide spacing.

Figure 10 shows a method that can be used to break off the hairspring when making space for the hairspring collet. The hairspring is held with tweezer "a" where the spring is to be broken off. Then, the spring is pulled over sharply with tweezer "b" in the direction of the arrow to cause a sharp bend next to tweezer "a." Now, if it is necessary, the end of the spring held by tweezer "b" can be moved back and forth to finish breaking off the spring. Care must be used when doing this operation to prevent the inner coils of the hairspring from being distorted.

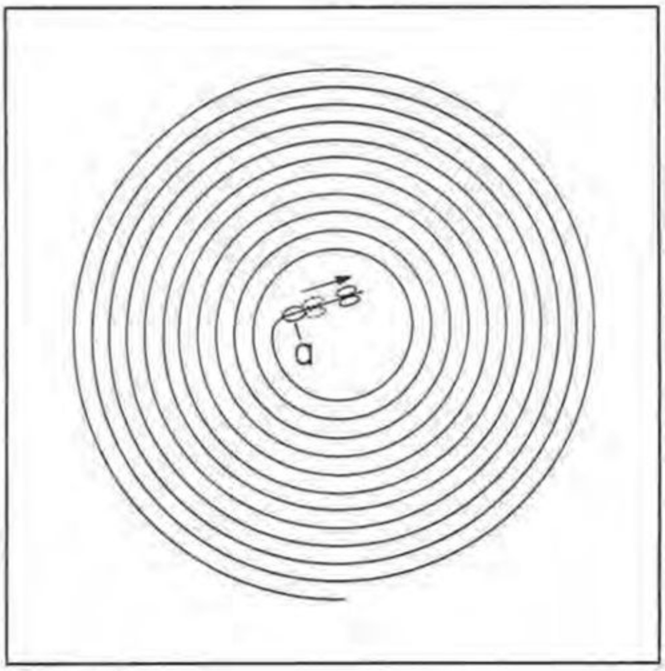

Figure 12.

Making the Tongue on the Hairspring

Figure 11 shows the first step in making the tongue on the hairspring. The hairspring is held with a tweezer where the spring is to be bent at the start of the tongue. The tweezer should have jaws that have smooth rounded corners. This is to prevent making a sharp bend in the tongue. As the spring is held with the tweezer, a needle is used to push the end of the spring in the direction of the arrow to form a rounded bend where the spring is being held with the tweezer. Note that the needle is used on the spring about halfway between the holding tweezer and the end of the spring. This is to avoid making a sharp bend at the holding tweezer.

Figure 12 shows the second step used to make the tongue. The spring is held with one tweezer at point "a" while a second tweezer with rounded polished jaws is used to make the straight section of the tongue. The second tweezer is used to grasp the spring next to the holding tweezer "a." The second tweezer is shown in broken line. Then, the second tweezer is slid along the coil toward its end, as shown by the arrow, to make the straight part of the tongue.

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Technically Watches

Antique Watch Restoration, Part CXIX

Colleting Hairsprings (2)

By Archie B. Perkins, CMW, FNAWCC, MBHI

When pinning a hairspring to the collet, the collet must be held on an arbor that will not allow the collet to rotate. The arbor must be shaped so a corner on the arbor goes into the slot of the collet to prevent it from turning during the pinning operation.

Figure 1 shows a hairspring collet holder that can be made by the watchmaker. View A shows a three-dimensional view of the holder. The holder is made of three parts which consist of a handle, a table, and the adjustable arbor. The table is fastened onto a shoulder on the end of the handle by friction and riveting. A hole is drilled lengthwise through the center of the handle for the center arbor. The arbor should fit the hole with a close sliding fit so the arbor can be adjusted lengthwise through the hole. A cut-away view of the holder is shown in View B, Figure 1.

The end of the arbor that holds the collet can have one of two shapes. The end of the arbor may be shaped like a cutting broach as shown in View "a," Figure 1, or it can be shaped as in View "b," Figure 1. An interchangeable round tapered arbor can be made up for holding an already colleted hairspring while truing it around the collet.

In lieu of the special holder shown in Figure 1, the hairspring collet may be held on a cutting broach. The broach is held in a pin vise. An arbor can be made to the shape that is shown in View "b," Figure 1 instead of using the broach for the arbor. A sewing needle is used to make this arbor. The needle is shaped on an India wheel while being held in a pin vise. A pin vise can also be used as a handle when the arbor is used to hold the collet while the spring is being pinned. When a spring is being pinned while using the broach or the arbor made from the needle, the thumb and forefinger are used underneath the hairspring to keep it level. When using the special colleting tool, the table keeps the hairspring level.

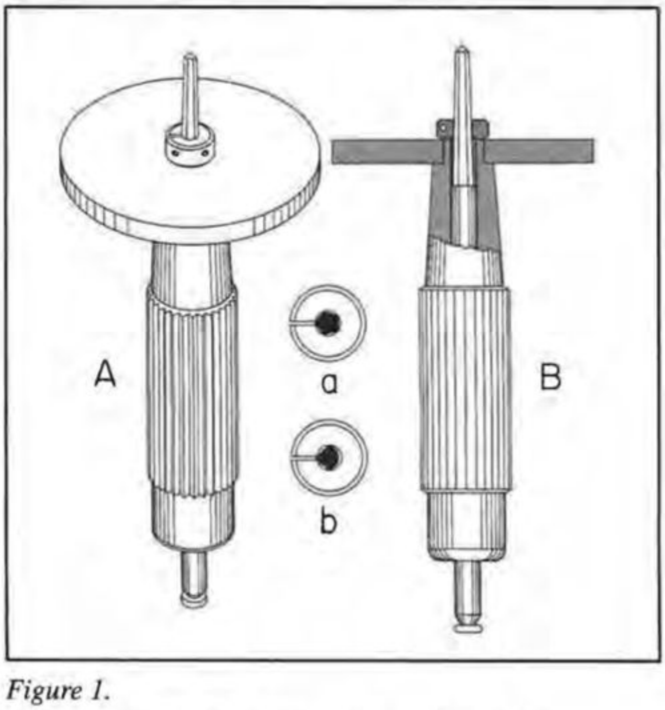

Figure 1.

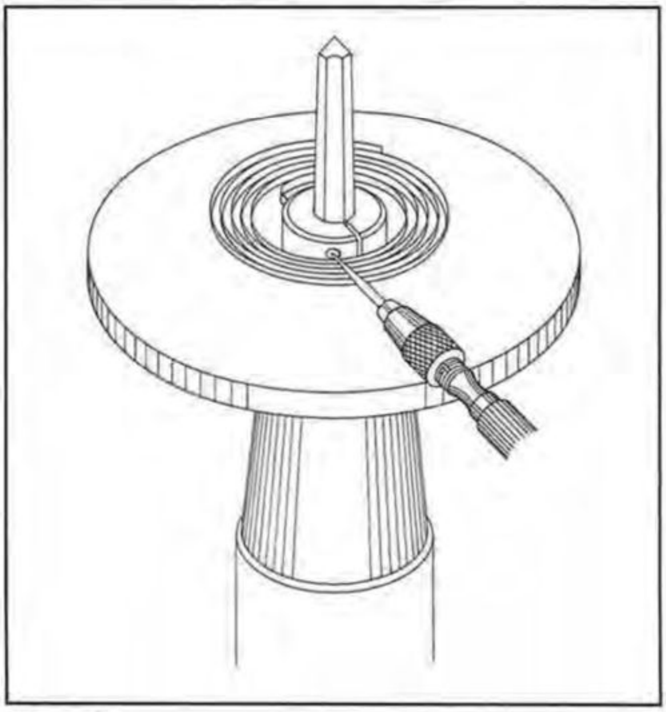

Figure 2.

Unpinning a Hairspring When Using the Old Collet

When fitting a new hairspring to a watch, it is usually better to use the old original collet if it is in good condition. This means that the watchmaker must remove the hairspring pin in order to remove the old hairspring from the collet. Figure 2 shows this operation. First, the collet is placed on the collet-holding arbor. Then, a sewing needle is used in a small pin vise when pushing the pin from the hole in the collet. The needle should have its end stoned flat just to remove the sharp tip of the needle. If this is not done, the sharp tip of the needle is likely to go into the end of the pin and spread the pin, making it more difficult to remove. The pin is pushed toward the curve in the tongue as shown in Figure 2. The pin is not pushed all the way from the hole with the needle. It is loosened in the hole enough so the pin can be removed with tweezers.

Making a New Hairspring Pin

It is not recommended to try to use the old hairspring pin for pinning the new hairspring to the collet. Tapered hairspring pins can be bought but they are not always the correct size for the job. A new taper pin of the proper size might need to be made by the watchmaker.

Figure 3 shows how a new taper pin is made. A hardwood filing block is held in the bench vise to support the wire while the pin is taper-filed. The filing block has assorted size tapered slots to accommodate different diameter wires for making different sized taper pins. The brass wire for the taper pin is held in a pin vise and rotated back and forth between the thumb and first two fingers while the pin is filed. The brass wire used should be hard brass. Brass wire can be hardened by rolling the wire between a smooth burnish file and a flat, smooth, hard steel surface. Most hairsprings are pinned to the collet with round taper pins as shown in Figure 4, View A. When the pin is tightened in the collet hole, a cross curve is formed on the tongue of the hairspring. This condition causes the tongue to have unneeded stress. To reduce the stress on the tongue of the hairspring, the pin can be filed flat on one side so the cross curve will not be made on the tongue. The flat side of the pin goes against the tongue of the spring as shown in View B, Figure 4. The flat-sided pin is used mostly to pin the hairspring on high-grade watches and chronometers. The round pin is used mainly on production watches.

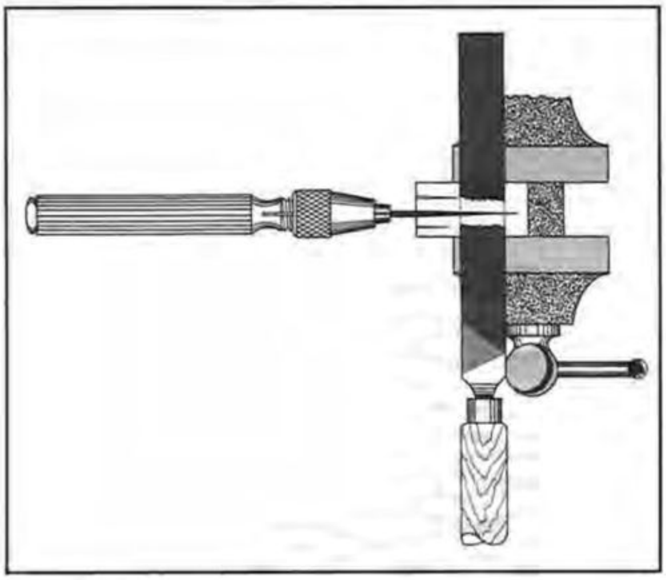

Figure 3.

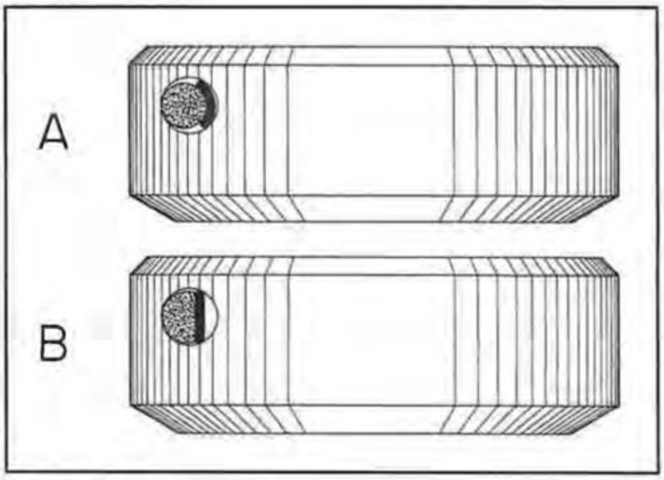

Figure 4.

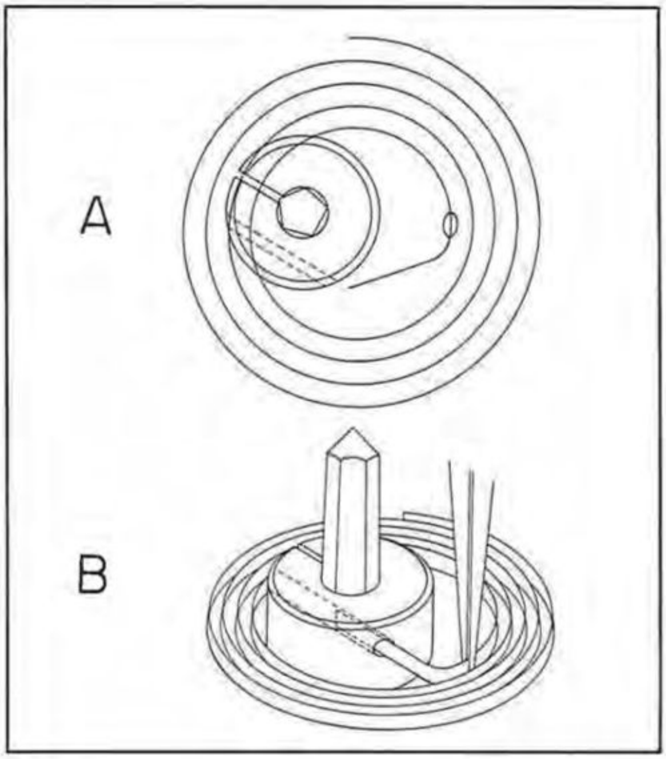

Figure 5.

Inserting the Tongue into the Hole in the Collet

Figure 5 shows how the tongue of the hairspring is inserted into the hole in the collet. When doing this operation, the hairspring is held with the tweezers near the bend in the tongue as shown in View A, Figure 5. The hairspring is then brought down over the arbor holding the collet. Then, the arbor and collet are turned counterclockwise as the tongue is inserted into the hole in the collet.

View B, Figure 5 shows the operation after the tongue has entered the hole in the collet. The tongue of the hairspring is inserted in the hole to a depth that allows the coils of the hairspring to be centered with the collet.

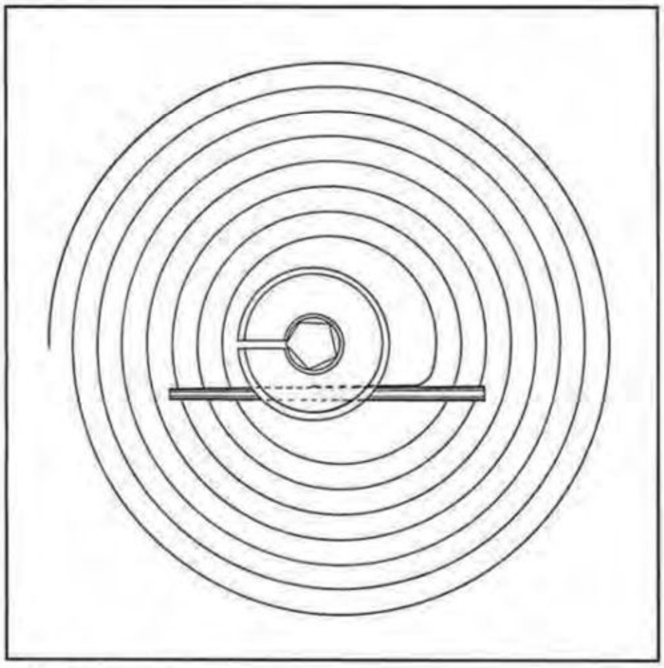

Figure 6.

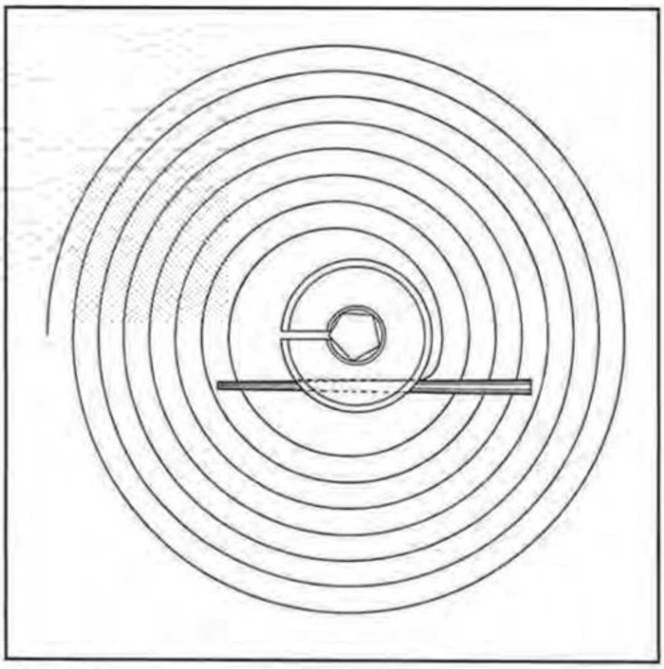

Figure 7.

Next, the hairspring pin is inserted loosely until the tongue is set at the proper location so the hairspring is centered on the collet. Figure 6 shows a hairspring which does not have the tongue inserted far enough into the hole in the collet. In this case, the pin is backed up enough that the tongue can be inserted deeper into the hole in the collet.

Figure 7 shows a hairspring that has the tongue inserted too far into the hole in the collet. In this case, the tongue needs to be moved out of the collet until the coils are centered with the collet.

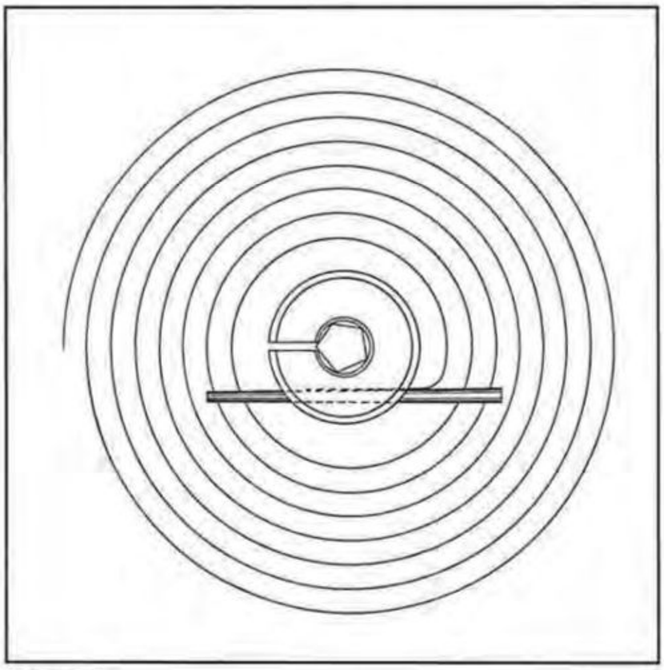

Figure 8.

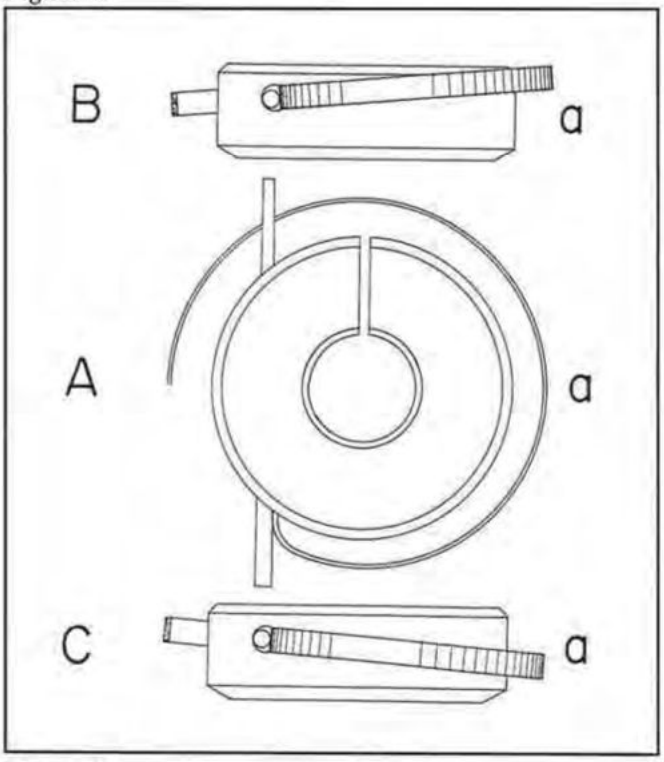

Figure 9.

Figure 8 shows a hairspring that is set centered with the collet. In other words, the tongue has been inserted into the hole the correct amount.

Leveling the Hairsping to the Collet

After the tongue of the hairspring has been inserted in the hole in the collet to the proper depth, the spring is leveled on the collet before tightening the hairspring pin in the hole in the collet. Figure 9 shows this process. View A shows a top view of the collet and a hairspring that is centered on the collet. View B, Figure 9 shows an edge view of the collet and hairspring in which the hairspring is not level with the collet. The spring is too high at "a" opposite the tongue. In this case, the first coil of the spring is pulled down at point "a." This can be done with a needle or tweezers. The hairspring would need to be loose enough to allow the spring to be leveled without having to bend the tongue. View C, Figure 9 shows a hairspring that is too low at point "a" opposite the tongue. In this case, the spring would need to be lifted up at point "a" until it is level with the collet.

Pinning the Hairspring to the Collet

After the hairspring has been centered to the collet and made level with the collet, the pin is tightened in the hole in the collet. Figure 10 shows how this can be done. View A shows how the pin can be pulled into the hole to tighten it. Tweezers are used for this purpose. In this particular case, a flat-sided pin is being used. Note that when a flat-sided pin is used, the pin can be turned in the hole to level the spring with the collet. After the pin has been pulled into the hole so it is almost tight enough, the pin is cut off just outside the curve in the tongue at point "a." Then, the pin is pulled further to tighten it and make the end of the pin flush with the collet.

Another method that can be used to tighten the pin and make it flush with the collet is to press the pin in with strong tweezers. One point of the tweezers would rest on the end of the pin and the other point would rest on the collet opposite the end of the pin. After the pin has been tightened, the small end of the pin can be cut off flush with the collet with cutting tweezers or small oblique angle nippers. View B, Figure 10 shows this operation being done. The reason that the large end of the pin is not cut off after the pin is made tight is that there is danger of cutting the hairspring off at the same time the pin is cut off.

Second Method of Pinning the Hairspring

Another method that can be used to pin the hairspring to the collet is shown in Figure 11. The pin can be round or flat-sided. With this method, the pin is first pulled or pushed into the hole until the hairspring is tight in the hole. Then, the pin is nicked on each side of the collet, flush with the collet, as shown in Figure 11, View A, point "a." The notches are cut in the pin with a Number 24 X-acto blade as shown in View B, Figure 11. The sharp edge of the blade should be made rough so the blade will actually saw the notches in the pin. Once the notches are cut three-fourths of the way through the pin, the ends of the pin are broken off at the notches.

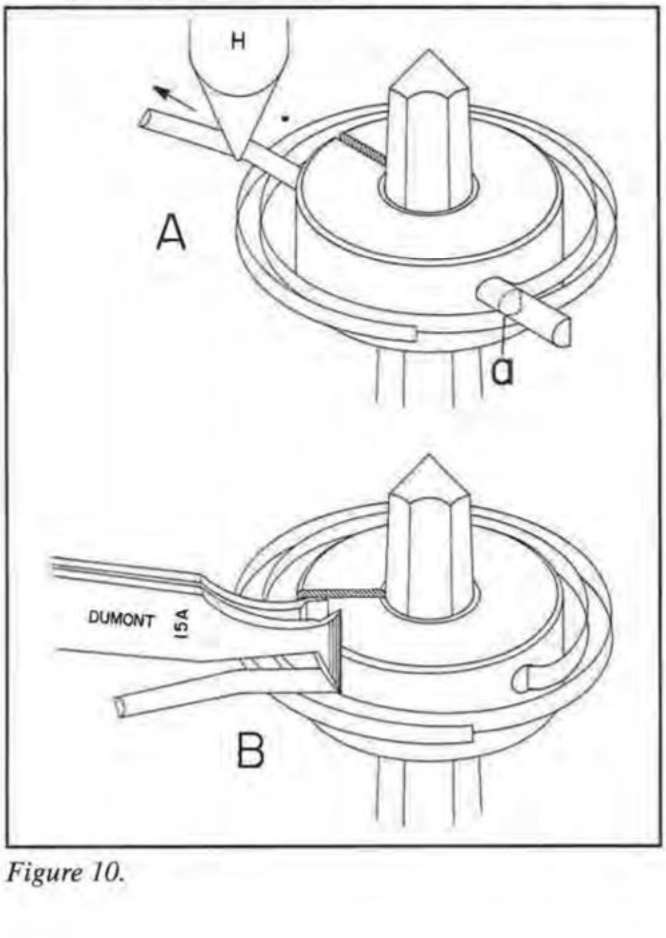

Figure 10.

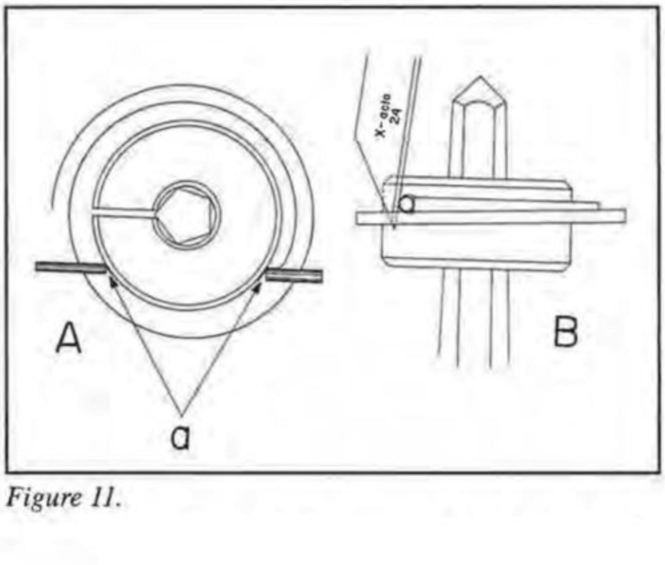

Figure 11.

Third Method of Pinning the Hairspring

Still another method that is sometimes used to pin hairsprings to the collet is shown in Figure 12. This method is used by some watch companies on low-grade, mass-produced watches where position adjusting is not of the utmost importance. One of the reasons this method is used is because it is a faster method. There are some faults with this method that are not present with the two previous methods.

This method is done in the following manner. The pin is pulled into the hole in the collet to tighten it onto the tongue of the hairspring. A small plier or strong tweezer is used for this operation. Then, the end of the pin is broken off by bending the pin sharply as shown in View A, Figure 12. There should be a pulling motion on the pliers as the bend is made. After a sharp bend has been made in the pin, it is bent back in the other direction to break it off. To make the bend in the pin, the arbor holding the hairspring is turned in a clockwise direction as the end of the pin is held with the pliers or tweezers. Then, to break off the pin, the arbor is turned in the opposite direction.

View B, Figure 12 shows how the large end of the hairspring pin is broken off. When this is done, there should be a pushing motion on the plier or tweezer as the arbor is turned counterclockwise to make the sharp bend in the pin. Then the arbor is turned in the opposite direction to break off the pin.

Some of the disadvantages of this method of pinning the hairspring are as follows. In the first place, the pin can loosen up in the hole as the large end of the pin is broken off. Secondly, the end of the pinhole becomes distorted as the pin is bent sharply to break it off. Thirdly, the end of the pin shown at "a," View B, Figure 12 remains bent over the edge of the hole which makes it difficult in some cases to remove the pin if the spring needs to be repinned. In the fourth place, when the large end of the pin is bent sharply to break it off, the pin is pulled away from the tongue of the hairspring as shown at "b," View B, Figure 12. This takes support away from the tongue of the hairspring. Since the pin supports the tongue at a different point than where the corner of the hole supports the tongue, there may be a significant difference in the vertical position rates of the watch.

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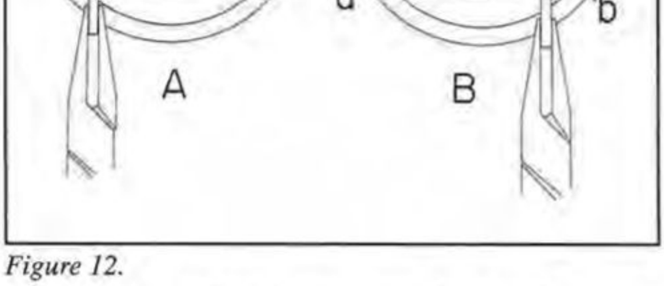

Figure 12.

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Technically Watches

Antique Watch Restoration, Part CXX

Truing Hairsprings Around the Collet

By Archie B. Perkins, CMW, FNAWCC, FBHI

After the hairspring has been pinned to the collet, it is trued around the collet. The more accurate the pinning job, the less truing needs to be done. In other words, if the tongue of the hairspring is made accurately and is pinned into the hole of the collet the correct distance, very little truing will need to be done.

Truing hairsprings around the collet is usually done in two phases, primary and final. The primary truing is done on a truing arbor, whereas the final truing is done with the hairspring and its collet seated correctly on the balance staff as it will be when the watch is operating properly. The primary truing on an arbor is for major bends that are difficult to do when the hairspring is attached to the balance staff. In other words, truing the hairspring on the arbor allows the major bends to be removed and the hairspring to be trued to within the ballpark. Then, the final truing can easily be done after the hairspring is attached to the balance staff.

Hairspring Truing Arbors

Figure 1 shows one style of hairspring truing arbor. This arbor is threaded with a threaded nut used to hold the hairspring collet flat against the seat on the arbor. The nut has a tapered end that goes into the hole in the collet to center the collet on the arbor. View B, Figure 1 shows a three-dimensional view of the hairspring attached to the arbor. The arbor is used between centers in the jaws of a hairspring truing caliper. The points on the ends of the arbor should be made with a 60° angle. The angle on the end of the nut should also be 60°. The arbor is frictioned into a white Plexiglas disc as shown. The disc furnishes a white background for the hairspring to allow for better viewing of the hairspring.

View A, Figure 1 shows the arbor and nut with their different dimensions. The arbor is made from a piece of high carbon water hardening drill rod. The arbor and nut are hardened and tempered to blue after they have been made. The threading of the arbor can be done with a Swiss screw plate. The nut is threaded with a matching tap made with the screw plate. The 60° bevel on the end of the nut must be turned so that it is centered with the thread in the nut. This bevel can be trued by screwing the nut onto the arbor with the beveled end outward. Then, the bevel is trued with the graver as the arbor is turning true in the lathe. The nut is tightened onto washers stacked on the thread of the arbor. This allows the bevel on the nut to be at the end of the arbor for turning the bevel.

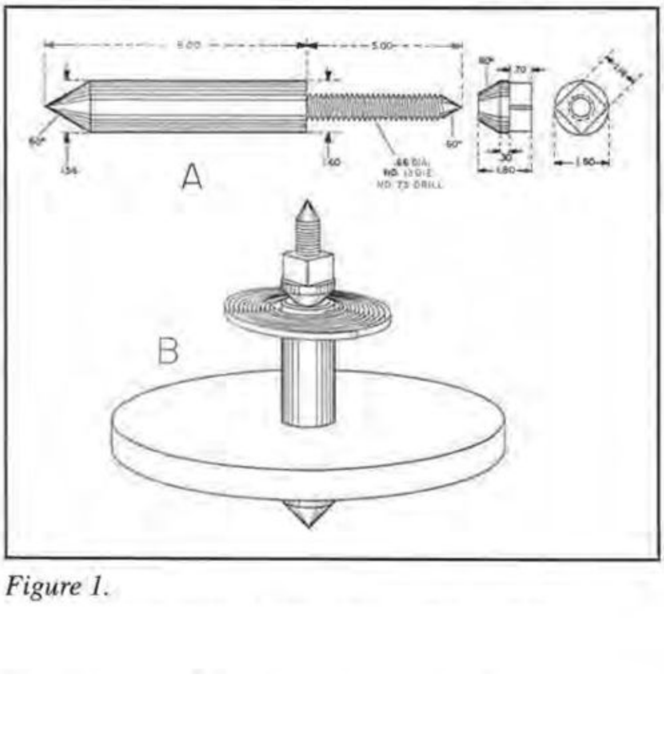

Figure 1.

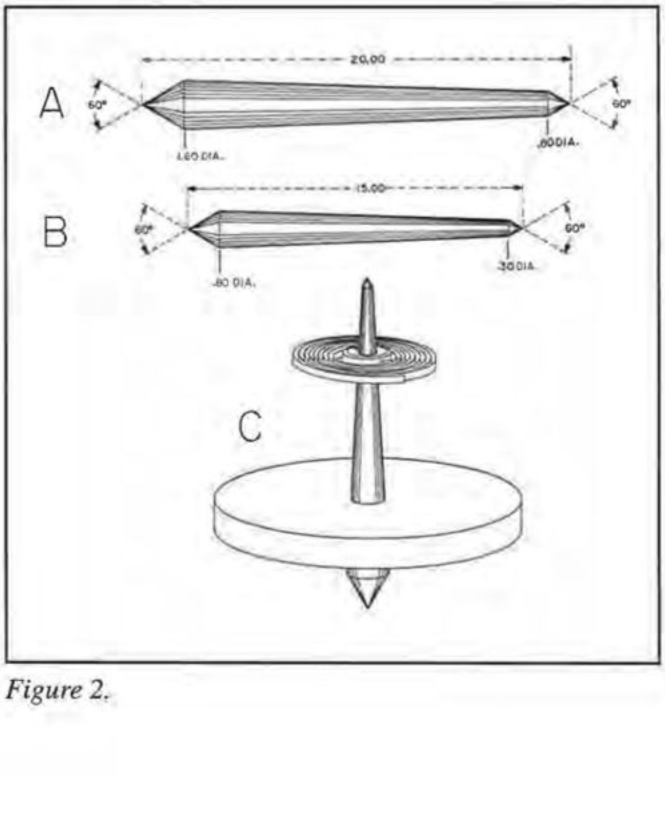

Figure 2.

Another style of hairspring truing arbor is shown in Figure 2. This style of arbor is easier to make than is the threaded style of arbor, and it can be turned from balance staff wire that has already been hardened and tempered to blue. Since this arbor is made from blue steel wire, this eliminates the need for hardening and tempering after the arbor has been made. This would eliminate the possibility of warping of the arbor during hardening and tempering.

This arbor is usually made in two sizes, one size (View A) for pocket watch hairsprings and another smaller size for wrist watch hairsprings (View B). View C, Figure 2 shows a three-dimensional view of the arbor with its Plexiglas disc and hairspring attached. The advantages of this style of arbor are that the arbor will take a variety of collet sizes, and it is very easy to remove and replace the hairspring and collet when changing hairsprings on the arbor.

Figure 3 shows how a hairspring truing arbor is held in a hairspring truing caliper. Centers have been spotted in the ends of the caliper jaws for the points of the arbor to turn in. The center can be made with a sharp center punch as the jaw of the caliper is held in a bench vise. One of the caliper jaws is usually thinned down to allow a better view of the hairspring around the collet. Sometimes the jaws on the opposite end of the caliper are jeweled for holding a balance wheel for truing the hairspring around the collet.

The Hairspring Truing Stand

Figure 4 shows a hairspring truing stand that can be made by the watchmaker for truing hairsprings around the collet. Although the stand is designed to sit on the bench while being used, it can also be held in the hand when used. The arbor has a 60° pivot on its lower end which works in a V-center screw like an alarm clock balance staff bearing screw. This screw is used to adjust the end shake on the arbor. The upper end of the arbor has a square-shouldered pivot which works in a hole in the bracket part of the stand. The arbor has a knurled disc frictioned to it for rotating the arbor. The Plexiglas disc "a" is cemented to the top of the bracket as shown by the arrow.

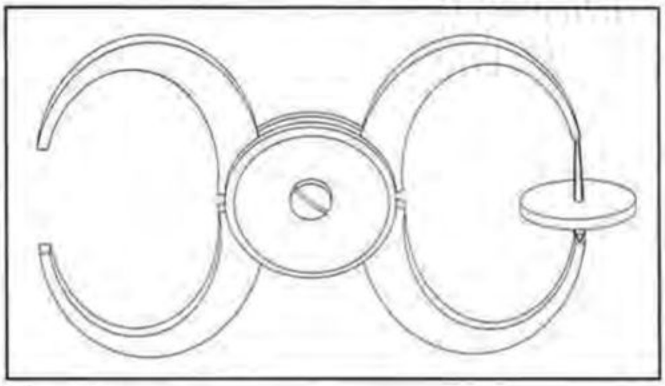

Figure 3.

Calipers for Holding the Balance Wheel

Figure 5 shows a hairspring truing caliper for holding balance wheels when truing hairsprings around the collet. This caliper, made by Levin, has a quick release jaw which allows a good view of the hairspring around the collet with plenty of room to manipulate the hairspring. This caliper will accommodate balance wheels from pocket watch sizes to the smallest wrist watch sizes.

Figure 6 shows another style of caliper used to hold a balance wheel while the hairspring is being trued around the collet. This caliper is a combination hairspring truing and balance poising caliper made by J. E. Kampe of Waltham, Massachusetts. The hairspring truing jaws have steel inserts for the balance staff to pivot into, similar to the jaws of a balance truing caliper. The jaws have been thinned down to give a good view of the hairspring around the collet.

The jaws on the other end of the caliper are jeweled for holding a balance wheel while it is being poised. The opening of the caliper jaws is controlled by screw "a."

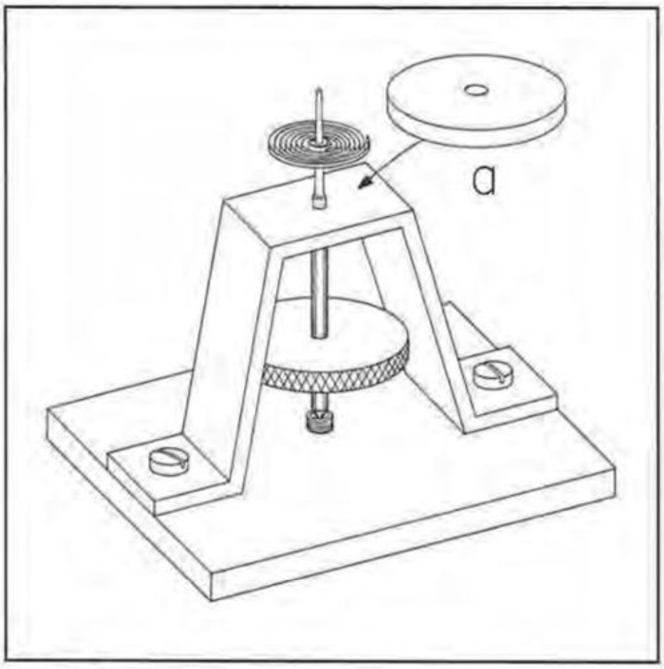

Figure 4.

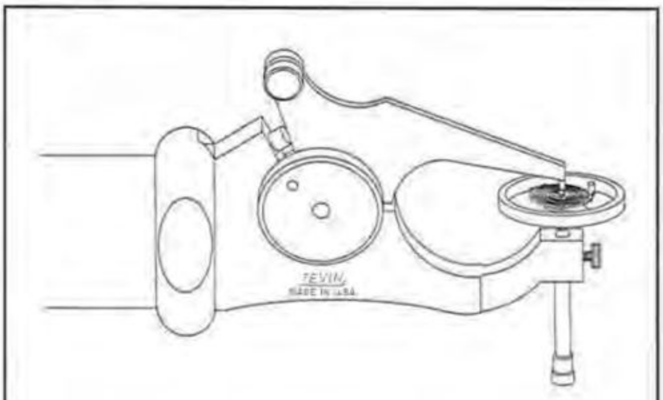

Figure 5.

Viewing Hairsprings when Truing in the Round

When truing hairsprings in the round, the spring is viewed from the top as shown in Figure 7. The eye is focused at one place to observe the first two or three coils of the hairspring at the collet as they pass the viewing point when the disc is turned. The disc is turned with the index finger in the direction of the arrow in this particular case. If the spring should be turned over on the arbor, the disc would be turned in the opposite direction. The rule is that the disc should be turned in a direction that allows the tongue of the spring to be seen first before the spiraling out of the spring is seen. If the disc is being turned in the proper direction, the coils of the hairspring will spiral outward.

When a hairspring is true in the round, the coils will spiral outwardly in a smooth fashion without any in and out motion as the disc is rotated. If the spring has a jerky in and out motion of the first coils at the collet, the spring is not yet true.

Viewing the Hairspring when Truing in the Flat

Figure 8 shows how to view the hairspring when truing it in the flat. The caliper is tilted so the spring is viewed at a 5° to 10° angle from an edge view as shown. If the spring is true in the flat, the coils will spiral outwardly without any up and down motion as the disc is rotated. Any up and down motion of the coils indicates that the spring is out of true in the flat. When viewing the spring as the disc is rotated, if there is any in and out motion of the coils, the spring is out of true in the round also. When rotating the disc, it should not be rotated so fast that the spring cannot be observed accurately. The disc should be rotated at a slow to moderate speed to observe the hairspring.

Truing a Hairspring in the Round

Figure 9 shows how a hairspring is trued in the round when the tongue has been pinned in too far, which I will call a short tongue. View A shows this short tongue condition. When the tongue is too short, the space between the collet and the first coil at the tongue is too small compared to the space between the collet and the first coil of the spring opposite the tongue. The space between the collet and the first coil develops too fast. To correct this condition, the spring either needs to be repinned so the tongue is longer, or the tongue can be re-formed so it is longer to allow more space between the collet and the first coil.

To re-form the tongue and make it longer, a hairspring pin is used as shown in View B, Figure 9. The first coil of the hairspring is pulled away from the collet to allow the hairspring pin to be inserted between the collet and the first coil as shown. Then, the first coil is pushed in at the arrow to bend the first coil around the hairspring pin. This operation re-forms the tongue, making it longer. View C, Figure 9 shows the results of this operation. At this point, the space between the collet and the first coil decreases instead of the desired increase. To create the desired in-

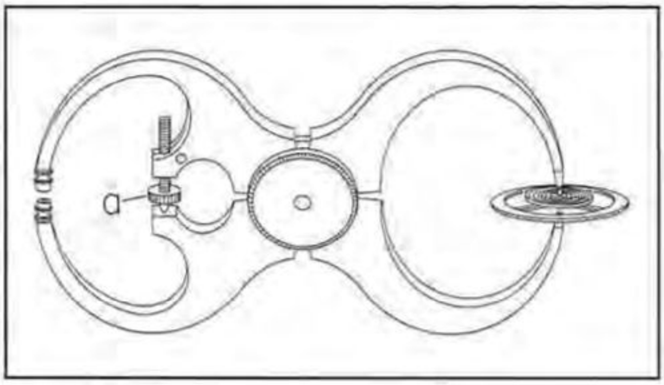

Figure 6.

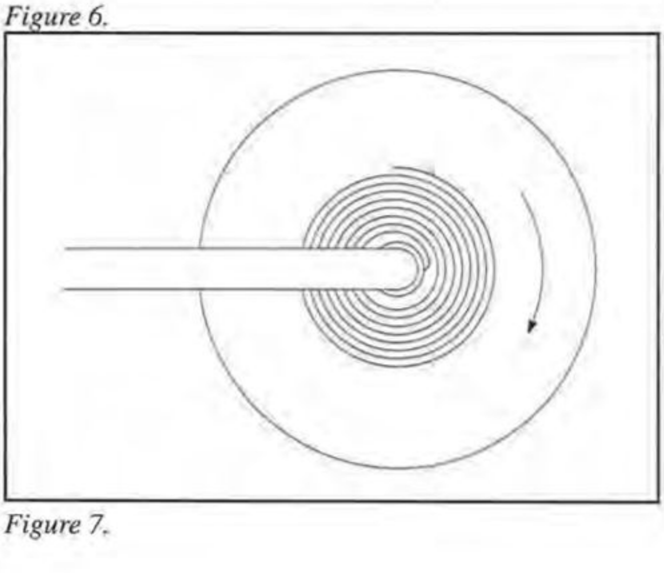

Figure 7.

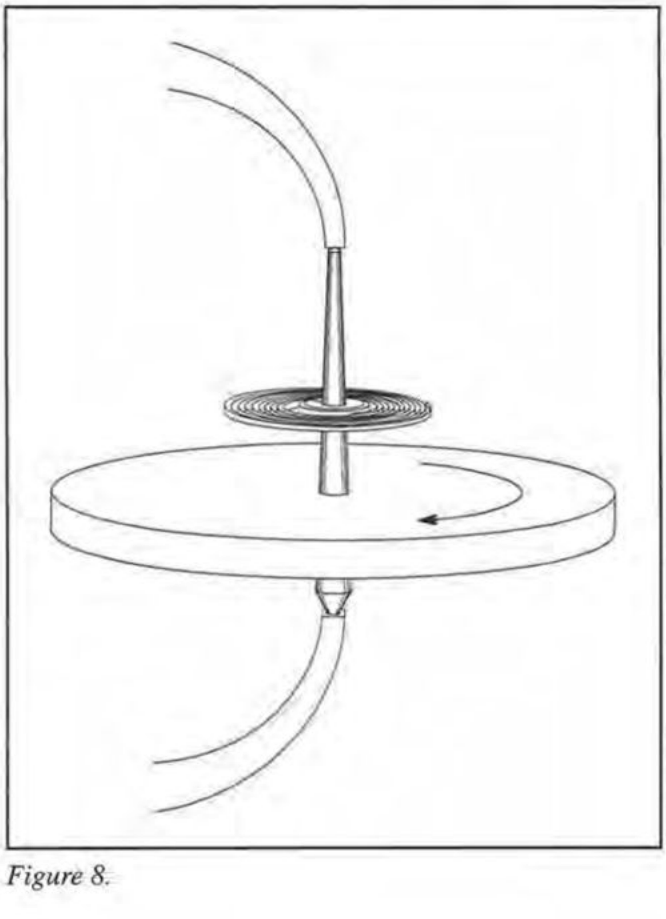

Figure 8.

crease in space, the first coil is pulled away from the collet as shown by the arrow in View C. The hairspring is shown corrected in View D, Figure 9. To be correct, the space between the first coil and the collet should have a gradual increase for the first turn.

Figure 10 shows how a hairspring is trued in the round when the tongue has been pinned out too far or too long. View A shows this condition. The space between the first coil and the collet decreases as the hairspring is rotated. To correct this condition, the spring can be repinned so the tongue is shorter, or the tongue can be reshaped to make it shorter. To reshape the tongue, a pair of tweezers is used as shown in View B, Figure 10 to press the tongue toward the collet to remove some of the bend in the tongue. This makes the tongue shorter and creates a condition like that which is shown in view C, Figure 10. The space between the first coil and the collet increases too fast at this point. To correct this condition, the first coil is pulled away from the collet as shown by the arrow in View C. The space is shown corrected in View D, Figure 10.

Figure 11 shows other out-of-round conditions that will be encountered in truing hairsprings around the collet. View A shows a condition where the tongue is the correct

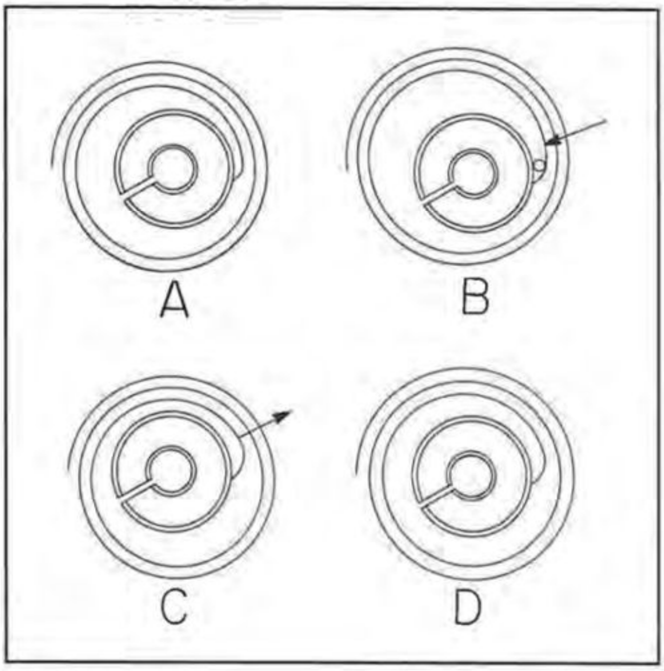

Figure 9.

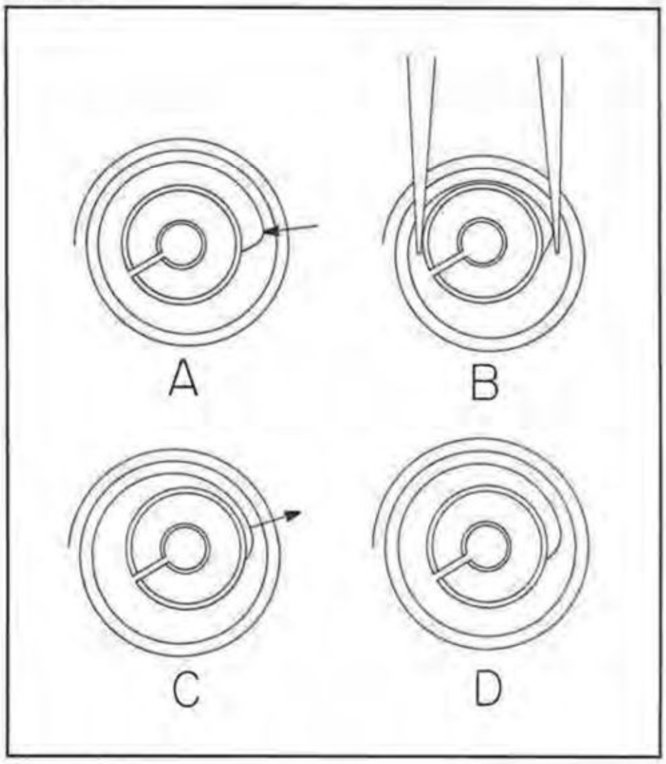

Figure 10.

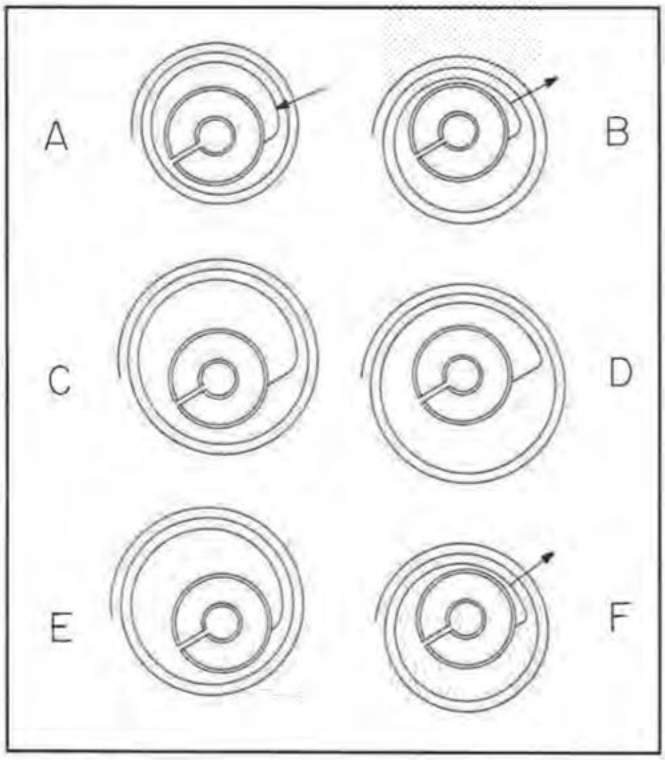

Figure 11.

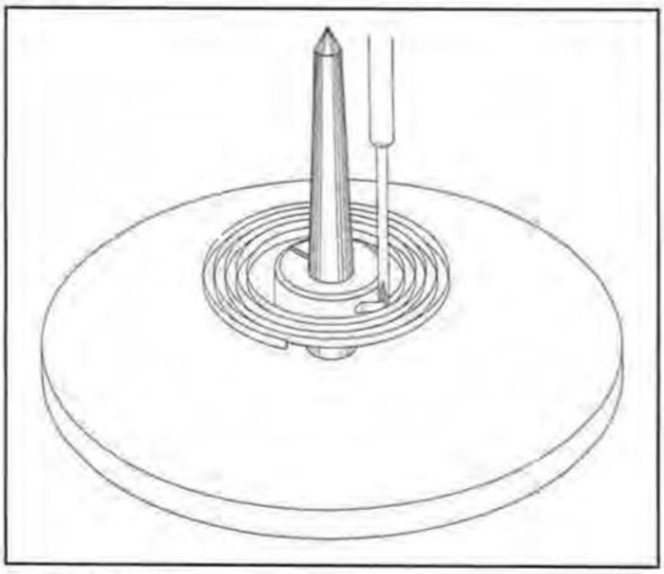

Figure 12.

length but the bend in the tongue is not sharp enough. This condition causes the space between the first coil and the collet to increase too fast. This condition can be corrected by pushing in on the first coil as shown by the arrow.

This condition can also be corrected by the method that is shown in Figure 12. This method is done with a tool made from a sewing needle. The end of the needle eye is ground away making an open-ended slot out of the eye of the needle. This slot is used to straddle the coil of the hairspring to shape the tongue of the hairspring as shown in Figure 12. In this particular case, the needle is placed over the coil as shown and is turned counterclockwise to decrease the radius of the bend in the tongue until the spring is centered on the collet. This tool can be used for corrections that require more than just pushing or pulling on the first coil. It is used for the reshaping of the tongue. The needle can be turned in one direction to make the bend in the tongue sharper and it can be turned in the opposite direction to reduce the sharpness in the bend of the tongue.

View B, Figure 11 shows a condition where the tongue is the correct length but the space between the first coil and the collet decreases. To correct this condition, the first coil is pulled out, as is shown by the arrow, until the spring is centered with the collet.

View C, Figure 11 shows a condition where the tongue is too long and the bend in the tongue is not sharp enough. The best way to correct this problem is to repin the hairspring to shorten the tongue, then reduce the radius of the bend in the tongue by using the needle tool.

View D, Figure 11 shows a condition where the bend in the tongue is too sharp and the tongue is too long. The spring should be repinned, making the tongue shorter. Then, the needle tool can be used to bend the tongue to correct the sharpness in the bend in order to center the spring around the collet.

View E, Figure 11 shows a condition where the radius of the bend in the tongue is too much and the tongue is too short. To correct this condition, the needle tool can be used to reshape the bend in the tongue, making the tongue longer to center the spring to the collet.

View F, Figure 11 shows a condition where the tongue is bent sharply and needs to be pulled out at the arrow. After this has been done, the tongue may be too short. If this is the case, the spring can be repinned so the tongue is longer, or the needle tool can be used to change the bend in the tongue to lengthen the tongue sufficiently.

Truing a Hairspring in the Flat

The task of truing hairsprings to the collet is greater when they are out of true in the round. Truing a hairspring in the flat should be done after the hairspring has been trued in the round. This is because the spring is less likely to be disturbed in the round when it is being trued in the flat. However, after a spring has been trued in the round and then in the flat, it should be checked in the round to make sure that the truth in the round has not been disturbed.

When checking a hairspring in the flat around the collet, the first coil of the spring should be level with the pinning hole and level with the collet, completely around the collet. The second coil must be level with the first coil. If the second coil is higher or lower than the first coil, this must be corrected before the first coil is trued to the collet. This correction is made by lifting up or pulling down on the second coil where it is the lowest or the highest. The first coil is trued in the same manner.

Much practice is needed for the watchmaker to master hairspring work. It is recommended that some old hairsprings be used for practice to gain the necessary skill before working on hairsprings that are fitted to a watch. ❐

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TECHNICALLY WATCHES

ANTIQUE WATCH RESTORATION, PART CXXI

STUDDING HAIRSPRINGS

By Archie B. Perkins CMW, FNAWCC, FBHI

Pinning a hairspring to the stud is basically the same as pinning it to the collet. The main difference is in the method used to hold collets and studs while the spring is being pinned to them.

Studs have been made in several shapes and attached to the balance cock in different ways. Figure 1 shows four different shapes of studs. View A shows a friction stud which has a round post that frictions into a hole in the balance cock. This type of stud was used in many of the lower-grade watches.

View B, Figure 1 shows a round hairspring stud. This style of stud is quite common in Swiss watches and some of the older American watches. When this stud has a V-groove milled lengthwise of the stud, a sharp pointed set screw is used to hold the stud in position in the hole in the balance cock. Another type of round stud is one which has a screwdriver slot in its end so it can be turned slightly for centering the hairspring between the regulator pins. This type of stud was used by Waltham and some other American watch companies.

View C, Figure 1 shows a D-shaped stud. This stud was used by Illinois, Hampden, and South Bend Watch Companies as well as some Swiss companies.

View D, Figure 1 shows the pie-shaped stud used by Elgin Watch Company and some Swiss companies. The pie-shaped stud was used in at least 90% of the older watches made by Elgin.

Some other styles of studs are shown in Figure 2. View A shows the triangular stud. This shape of stud was used by Hamilton as well as some Swiss companies.

View B, Figure 2 shows the square-shaped stud. This stud was used by the Howard Watch Company in many of its models.

View C, Figure 2 shows the pentagon-shaped stud used exclusively by the Hamilton Watch Company.

View D, Figure 2 shows the bar stud used in many of the old American and English watches. These studs were usually fastened to the upper plate with a screw and steady pins.

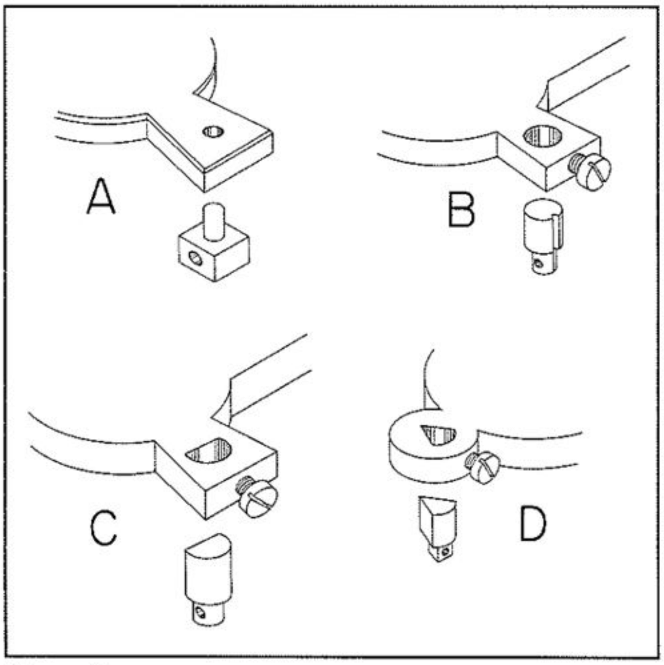

Figure 1.

When pinning the hairspring to the stud a tool is needed for holding the stud.

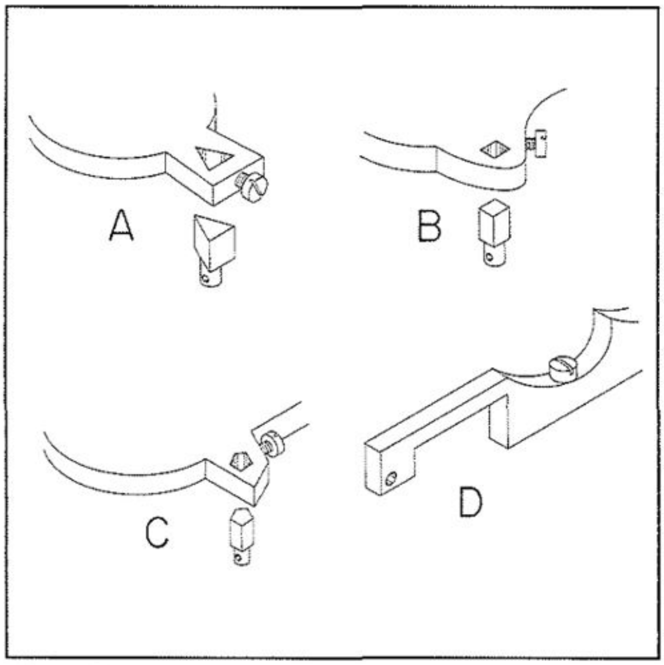

Figure 2.

Floating Studs

Another type of stud is called the floating stud. This type of stud can be made in several shapes. The sole purpose of the floating stud is to maintain the true shape of the hairspring during the disassembly and assembly of the hairspring and its stud from and to the balance cock. The floating stud is not attached to the

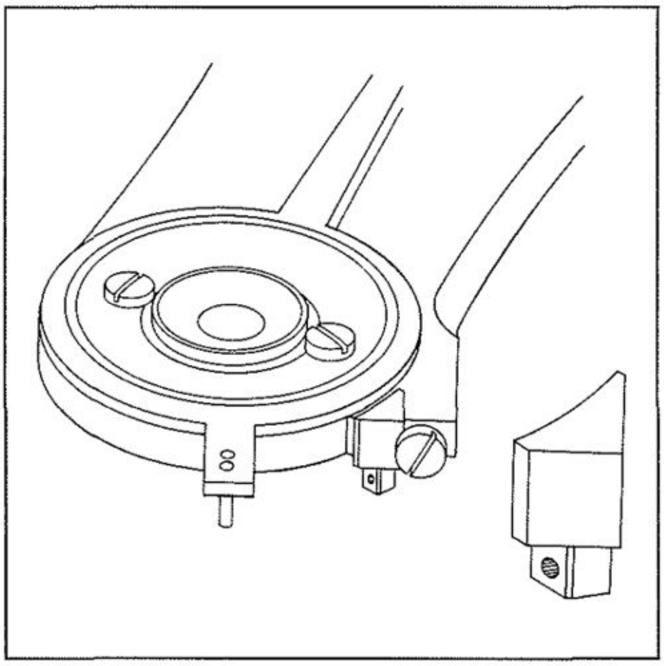

Figure 3.

balance cock until after the balance wheel and hairspring have been placed in the watch and the balance cock has been tightened down on the plate with its screw. After the balance and cock have been placed in the watch, the balance is turned so the hairspring stud can float to where it will be attached to the balance cock. When the stud is in position and before being tightened, the hair-

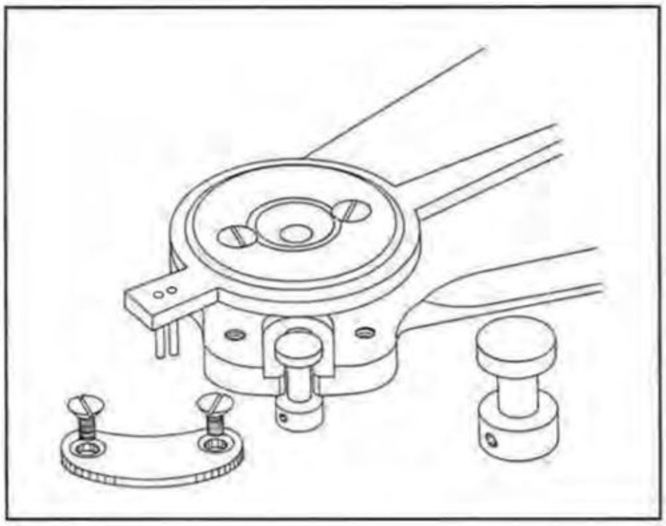

Figure 4.

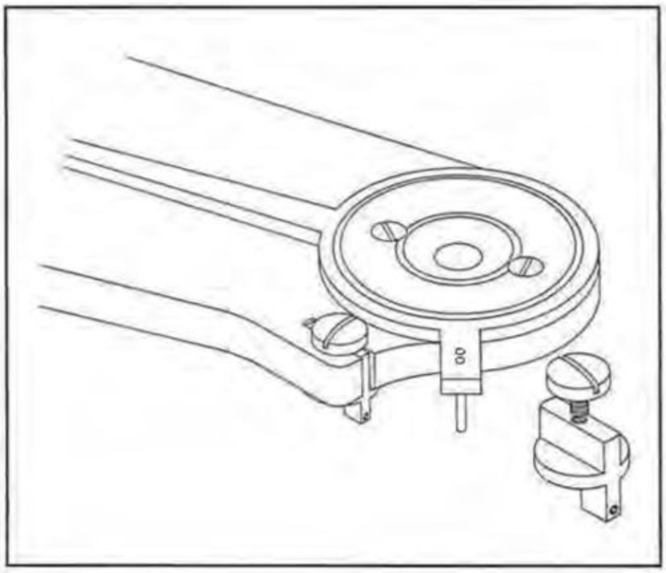

Figure 5.

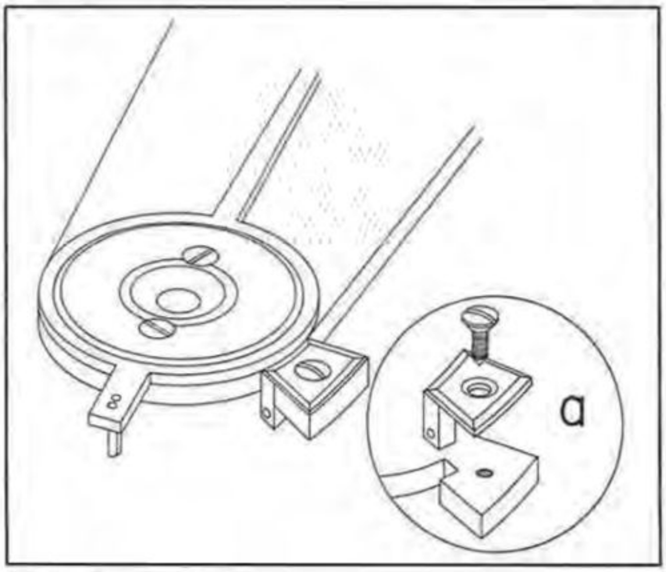

Figure 6.

spring is placed between the regulator pins. Then, the stud is tightened to the balance cock.

Figure 3 shows the Waltham floating stud. This stud has a triangular shape with one surface having a concave shape. The stud is held in a V-groove in the balance cock by the head of the screw. The illustration shows a view of the stud in position as well as an enlarged view of the stud.

Figure 4 shows the Hamilton floating stud. This particular floating stud is sometimes referred to as a collar button stud because it is shaped similar to the collar buttons that were used years ago in shirt collars. This stud fits into a slot in the edge of the balance cock as shown and is held in place with a stud strap and two screws. The strap goes over the end of the stud and is tightened on top of the end with the two screws. An enlarged view of the stud is also shown in the illustration. This type of arrangement was used on some Swiss watches and other American watches.

Figure 5 shows another style of floating stud. This stud fits into a slot in the edge of the balance cock and is held in place with a screw threaded into the top of the stud. The stud is tightened to the balance cock between the shoulder on the stud and the head of the stud screw. One disadvantage of this style of stud is that it is complicated to make. An enlarged view of the stud and its screw is shown in the illustration.

Figure 6 shows a beautiful floating stud which is used in some high-grade watches. This stud is a cap which has a square-shaped post that fits into a slot in the balance cock. This is shown in inset "a" of Figure 6. The square section of the stud has a hole for the hairspring to be pinned into. The cap part of the stud is fastened to the balance cock with a screw.

Tools for Holding the Hairspring Stud

When pinning the hairspring to the stud, a tool is needed for holding the stud. Figure 7 shows one type of studding table. The jaws of the table are spread to receive the stud by pressing in on the plunger on the side of the tool. The jaws are spring loaded.

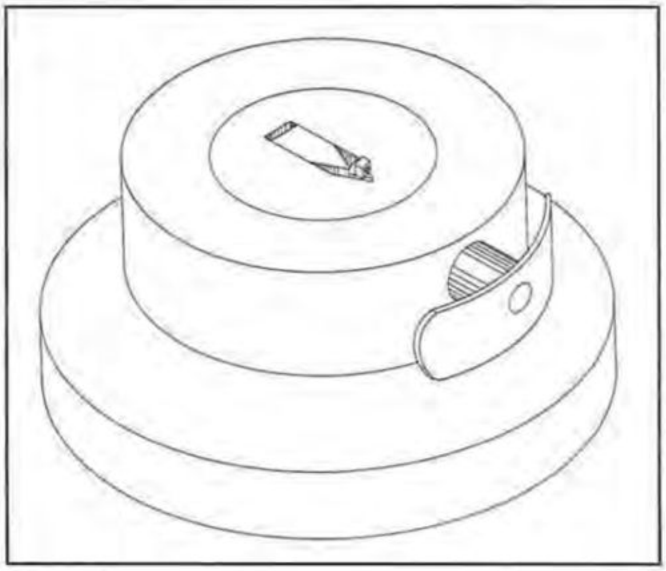

Figure 7.

The stud is held between the V-corner of one jaw and the point of the other jaw.

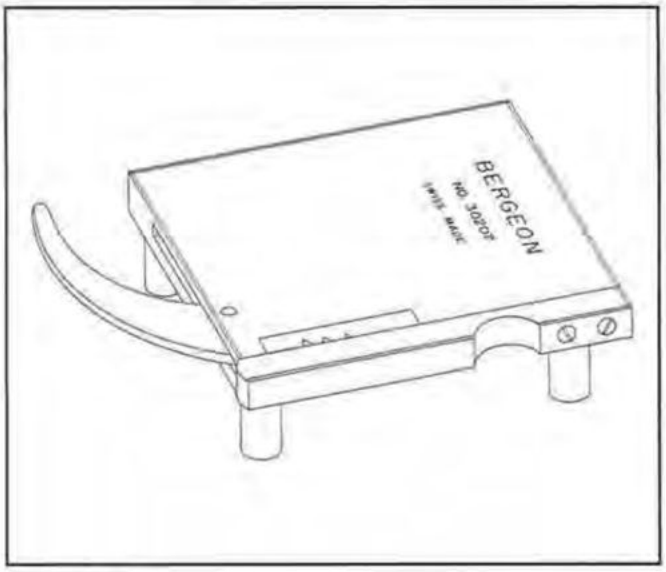

Figure 8.

Another style of studding table is shown in Figure 8. This studding table is made by Bergeon. One jaw of the tool is an insert in the frame of the tool. This jaw has assorted sized V-notches. The other jaw of the tool is a steel bar fastened to the side of the frame next to the inserted jaw. The steel jaw has spring action and can be sprung open to receive a stud by pressing in on the lever at the end of the tool. The largest V-notches are placed nearest to the outer end of the jaw.

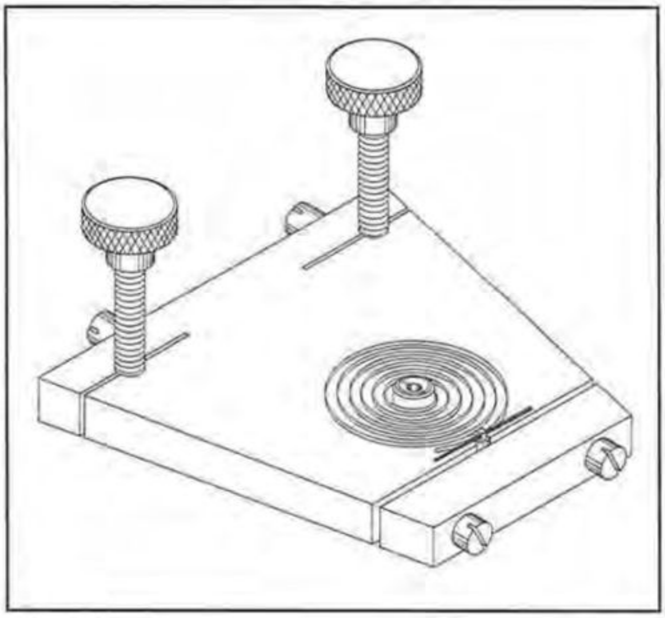

Figure 9.

Another tool that can be used for holding a hairspring stud while studding the hairspring is the screwhead finishing tool. This is shown in Figure 9. When using the screwhead tool for studding a hairspring, the leveling legs of the tool can be backed up so their ends are flush with the tool, or the legs can be removed completely.

Using the Balance Cock to Hold the Stud

The stud can be held in the balance cock while pinning the hairspring. This is shown in Figure 10. The index finger is used to hold the balance cock down on the top of the bench while the pinning is being done. Care must be used to prevent doing damage to the balance cock during the pinning operation. This method is excellent to use when the spring needs to be lengthened or shortened slightly.

Lengthening or Shortening the Hairspring

When the hairspring needs to be lengthened or shortened at the stud, it can be done as shown in Figure 11. View A shows how the hairspring pin is removed for changing the length of the hairspring. Strong tweezers are used for this purpose. One jaw of the tweezers is placed on the small end of the pin and the other jaw is placed on the stud as shown. Then, the tweezers are squeezed to extract the hairspring pin. If the end of the pin should be too short to allow the pin to be extracted with the tweezers, then another method must be used to remove the pin. In this case, a small sewing needle can be used in a pin vise or handle to push the pin from the hole in the stud. The very tip of the needle point should be stoned flat for pushing the pin out of the hole. If the point of the needle is sharp, it is likely to go into the end of the pin and spread the pin, making it more difficult to remove the pin. It is almost always better to first file the end of the pin being pushed on to make it flush with the stud.

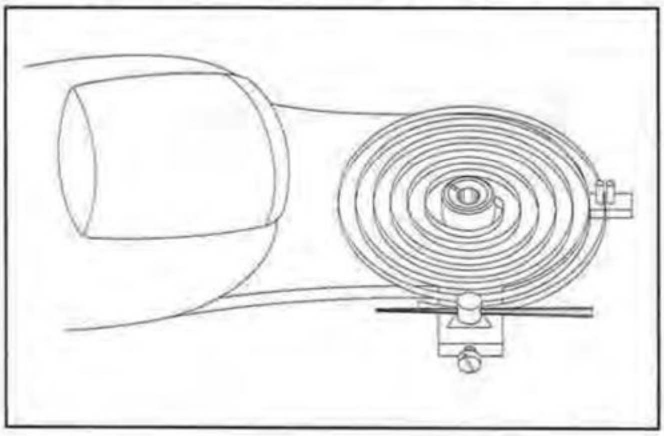

Figure 10.

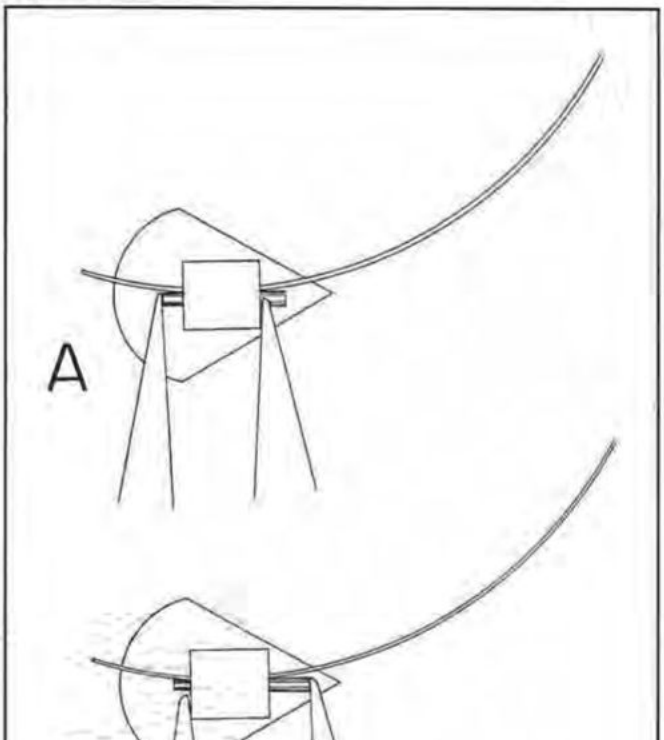

Figure 11.

After the pin has been removed and the length of the hairspring is adjusted, the pin is replaced as shown in View B, Figure 11. To replace the pin, the tweezers are used by placing one jaw on the large end of the pin and the other jaw on the side of the stud as shown. Then, the tweezers are squeezed to press the pin in tightly. If the old pin is damaged during the removal process, a new pin must be fitted.

Fitting a New Stud Pin

Figure 12 shows the process used to fit a new stud pin. It is usually more desirable to use a factory-made taper pin if the proper size is available. View A, Figure 12 shows one method of fitting a new stud pin. The taper pin is inserted in the stud hole beside the hairspring as shown. The pin should enter the hole in the

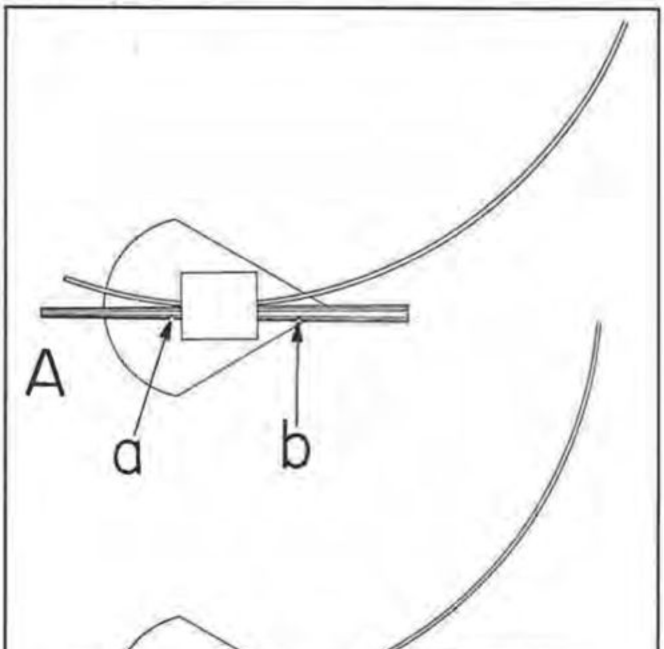

Figure 12.

same direction as does the spring. The pin is pushed or pulled into the hole until it is almost tight. Then, the pin is nicked at point "a" close to the block on the stud. Next, the pin is nicked at point "b." Then, the pin is removed and cut off at the nicks. The pin can be nicked with a Number 24 X-acto blade. After this, the pin is replaced in the hole and pressed into the hole to tighten the hairspring in the hole of the stud. Make sure the spring is level and square with the stud before tightening the pin. The method shown in View B, Figure 11 is used to press the pin tightly into the hole of the stud. Note: If the nicks in the pin are made deeply enough, both ends of the pin can be broken off without removing the pin from the hole. After the ends of the pin have been broken off, the pin is pressed into the hole in the stud.

Another method that can be used to fit a new stud pin is shown in View B, Figure 12. To use this method, the pin is inserted in the hole in the stud to a point where it is almost tight enough. Then, a pair of fine-cutting tweezers are used to cut the pin off at point "a." The cutting tweezers are moved on the pin as shown until the cutting edges reach point "a." At the same time, the jaw of the tweezers will move the outside coil of the hairspring over to allow the spring to be cut off at the proper place. After the pin has been cut off at "a," the pin is pressed tightly into the hole. Next, the small end of the pin is cut off with the tweezers. Stud pins should never be cut off or broken off flush with the stud. They should extend from each side of the stud about .50 mm. This makes it easier to remove and replace the stud pin when changing the length of the hairspring if the timing should be off slightly. When pinning the spring to the collet, the space around the collet is more critical which requires that the pin be cut off flush with the collet to prevent the hairspring from touching the end of the pin.

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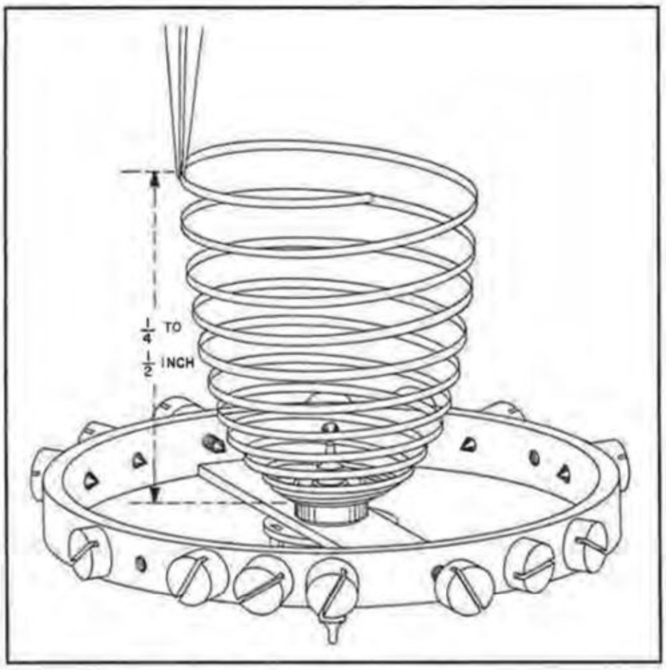


Figure 1.

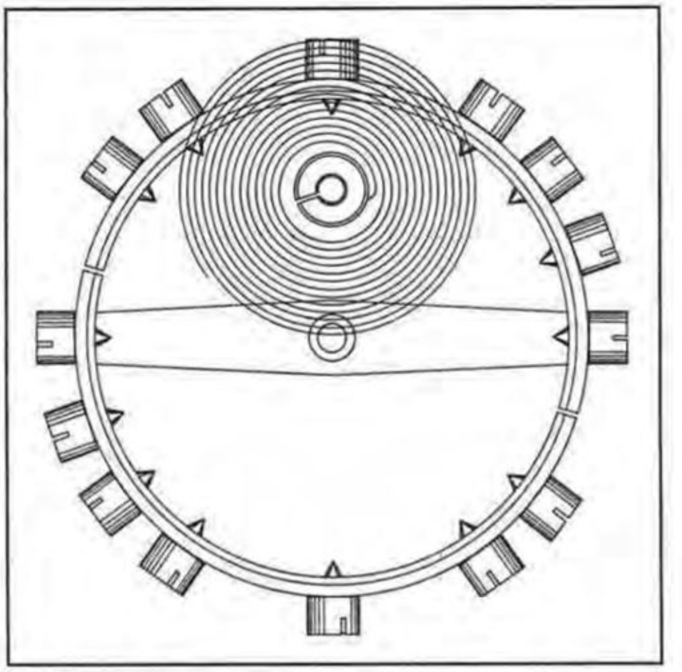


Figure 2.

TECHNICALLY WATCHES

ANTIQUE WATCH RESTORATION, PART CXXII

SELECTING AND FITTING FLAT HAIRSPRINGS

By Archie B. Perkins, CMW, FNAWCC, FBHI

One of the most important parts of hairspring work is the selection of a correct hairspring for a particular watch. First of all, the hairspring selected must be made of the proper material for the particular balance wheel.

If the balance wheel is a bimetallic split wheel, a steel hairspring must be fitted to the balance wheel; otherwise, the temperature compensation of the watch will be altered. The bimetallic balance wheel compensates for the changes in the length and elasticity of the steel hairspring. If an alloy hairspring is fitted to a bimetallic split balance wheel, the balance wheel will overcompensate when the watch is subjected to heat and cold. On the other hand, if a steel hairspring is fitted to a solid monometallic balance wheel, the temperature compensation will also be altered. The balance wheel will not compensate for the changes in the steel hairspring when the watch is subjected to heat and cold conditions. Therefore, a steel hairspring is fitted to a bimetallic balance wheel and an alloy hairspring is fitted to a monometallic balance wheel.

When selecting a hairspring for a given balance wheel, some rule-of-thumb methods can be used. One rule-of-thumb method is shown in Figure 1. When a hairspring is attached to the balance wheel and the balance wheel is suspended by the hairspring, the hairspring should extend a distance of between 1/4" and 1/2" if there is a possibility that the hairspring can be used for the balance wheel. This distance varies with the number of vibrations that a balance wheel should make for the watch to keep correct time.

A fast-beat watch needs a stronger hairspring to cause the balance wheel to beat faster. In this case, the hairspring will not extend as far as one for a slow-beat watch. A good example of this is a 100th-second stop watch. This watch has an extremely fast-beat balance wheel. The hairspring for this balance wheel extends less than a quarter of an inch when the balance wheel is suspended by the hairspring. An 18,000-beat watch has a hairspring which extends about 3/8" on the average.

Another rule-of-thumb method that can be used when selecting a flat hairspring is shown in Figure 2. This method relates to the diameter of the hairspring. A hairspring which is timed to the balance wheel should have a diameter that is equal to the radius of the balance wheel, including the screw heads as shown in Figure 2. Note that the spring can be slightly larger than this if it is to have an overcoil. Also, the hairspring can be slightly smaller if it needs to be, in order to fit the regulator pins when it is used as a flat hairspring.

Still another rule-of-thumb method that is used when selecting a hairspring is shown in Figure 3. This method uses the rule that a hairspring which is timed to the balance wheel should have between twelve and sixteen coils. This illustration shows two different hairsprings that are the same diameter but one has sixteen coils and the other hairspring has only twelve coils. This indicates that for a given diameter, the number of coils varies with the closeness of the coils. There seems to be an average of fourteen coils for the hairspring. Note: One exception to this rule is in older watches, such as verge watches, the hairspring usually has only four to six coils. The coils are spaced farther apart so the diameter of the hairspring is equal to the radius of the balance wheel. The verge balance wheel with hairspring is shown in Figure 4. This number of coils is sufficient because the balance wheel takes less than a turn of motion. This hairspring is short and would be quite restrictive on the motion of a modern balance wheel which is expected to take an arc of motion of one and one-half turns.

Fitting a New Flat Hairspring

New hairsprings can be obtained with or without the collet. If the original collet is to be used, it would be better to use an uncolleted hairspring. The new hairspring should be colleted so it develops in the proper direction when the top of the collet is in an upward position. If an already colleted hairspring is used, it must develop in the proper direction. Figure 5 shows how to determine which direction the hairspring needs to develop to fit the watch. View A, Figure 5 shows the balance cock for a left hairspring. A left hairspring spirals outward from the collet in a counterclockwise direction when the top of the collet is upward.

View B, Figure 5 shows the balance cock for a right hairspring. A right hairspring spirals outward from the collet in a clockwise direction when the top of the collet is upward.

A new hairspring usually has two or more extra coils to allow for fitting the hairspring to a variety of balance wheels. After the timing point is located, the extra coils are removed. The timing point is at the regulator pins. If the timepiece is free-sprung (there is no regulator), then the timing point will be at the stud. The timing point is found by vibrating the hairspring or timing the vibrations of the balance wheel and hairspring. Note: Instructions on vibrating hairsprings will be discussed next month.

Figure 6 shows a new hairspring being fitted to a watch. The new hairspring is shown centered on the balance cock. The broken lines show the unneeded coils of the hairspring. These will be broken away after the timing point is located. The timing point, in this case, is on the third coil of the hairspring at the regulator pins. See Point

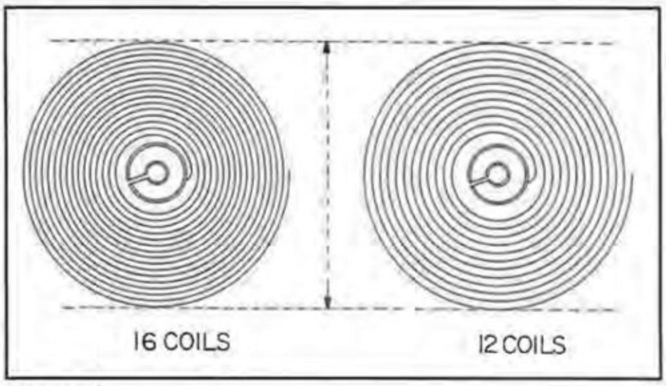
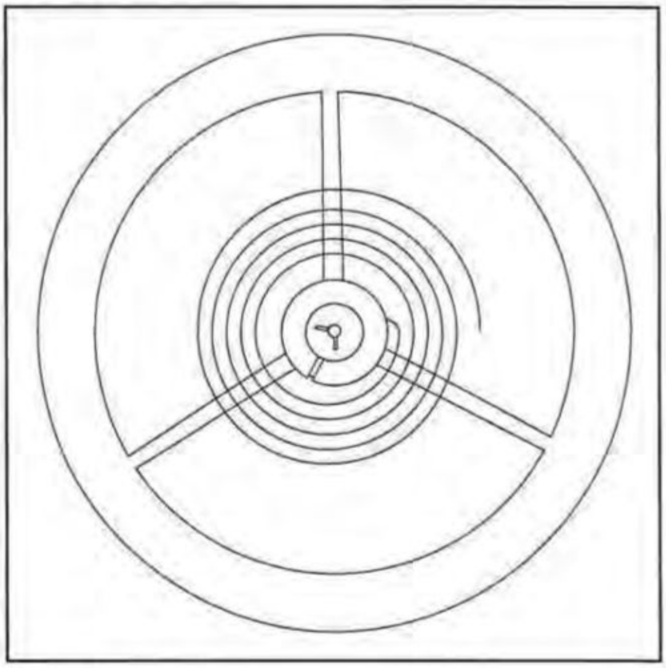


Figure 3.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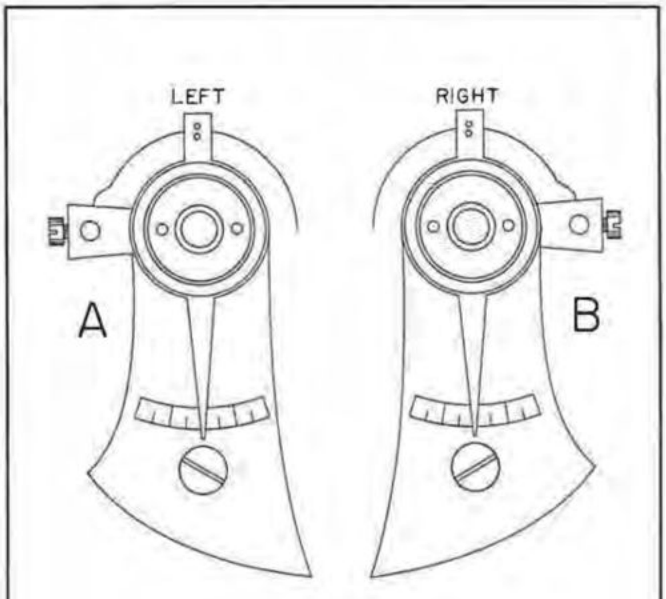

Figure 5.

"a." Point "b" shows where the extra coils should be broken away. This point is 45° beyond the hairspring stud. This extra length allows for some adjustment in the length of the hairspring if the watch should be too fast.

After the timing point is located and the excess coils are removed, the regulator sweep of the hairspring is formed. This is shown in Figure 7. View "a" shows the point where the outside coil is bent outward when forming the regulator sweep. View "b," Figure 7 shows where bends are made near the stud to keep the hairspring centered with the balance hole jewel and to circle the regulator sweep. This bending is necessary because the stud is placed farther from the center than are the regulator pins. This is done to allow extra space between the stud and the second coil of the hairspring to prevent the coil from hitting the stud when the watch is operating.

Hairspring That Is Too Large

It will be found occasionally that the hairspring is too large in diameter for the regulator pins' distance. In other words, the timing point on the hairspring is too far out on the hairspring. This condition indicates that the hairspring is too strong for the weight of the balance wheel and the timing point had to be moved out farther to make the hair-

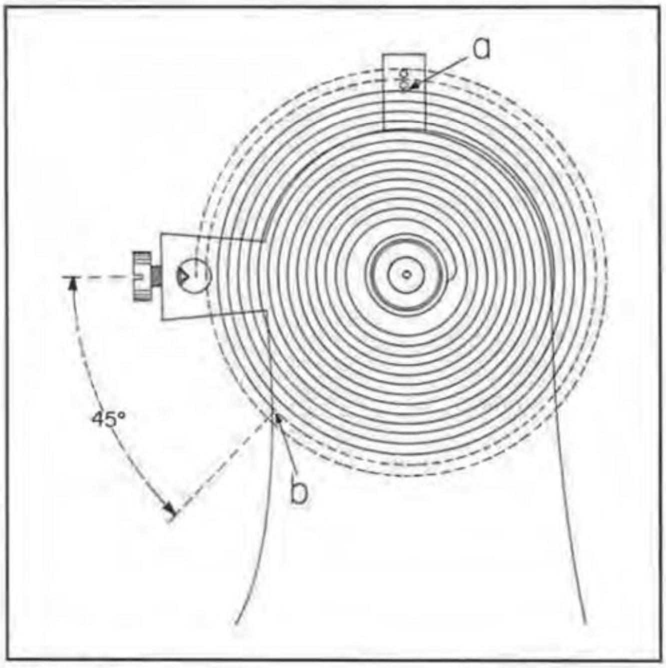

Figure 6.

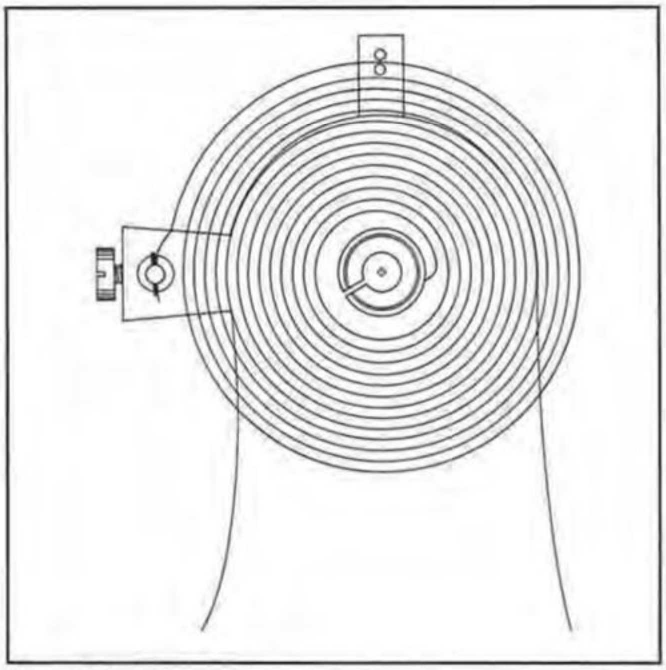

Figure 8.

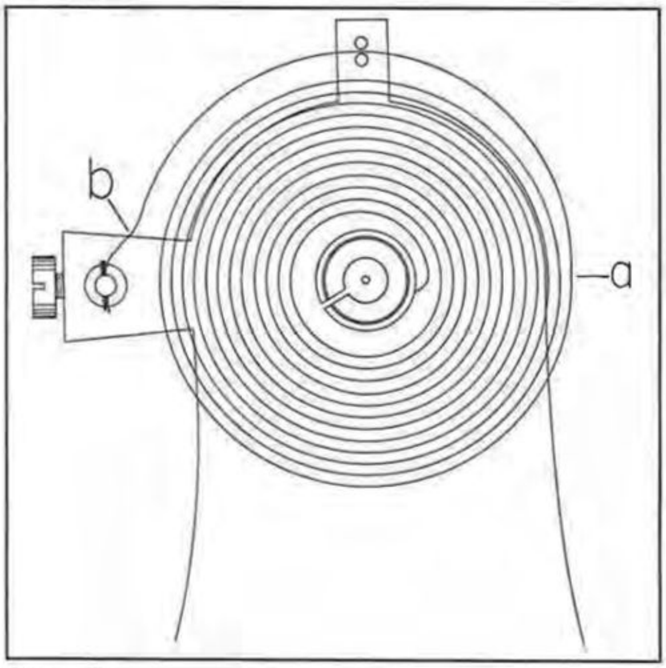

Figure 7.

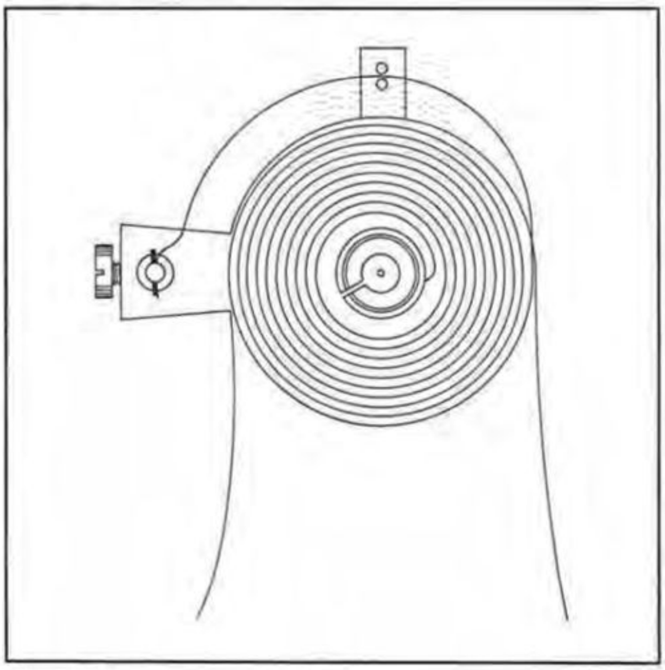

Figure 9.

spring weak enough for the balance wheel.

Figure 8 shows a hairspring that is one coil too large for the regulator pins' distance. This causes the hairspring to be too crowded. With this condition, there is the danger of the second coil of the hairspring touching the inside regulator pin when the hairspring is vibrating. This would cause the watch to run fast. The cure for this condition is to fit a slightly weaker hairspring which will place the timing point one coil inward allowing more space between the second coil and the regulator pins.

Hairspring That Is Too Small

Figure 9 shows a hairspring that is too small for the regulator pins' distance. This indicates that the hairspring is too weak for the watch. When the body of the hairspring is centered with the balance hole jewel, this creates too much space between the inside regulator pin and the second coil of the hairspring. In this case, there is not the danger of the second coil touching the regulator pin as when the hairspring is too large. When the hairspring is too small in diameter or too short, there may be more difficulty in timing and adjusting the watch. When fitting a flat hairspring, we are limited by the regulator pins' distance. When fitting an overcoiled hairspring, we are not limited. With an overcoiled hairspring, one coil smaller or larger does not make much difference. In other words, we are not so limited with an overcoiled hairspring as with a flat hairspring.

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TECHNICALLY WATCHES

ANTIQUE WATCH RESTORATION, PART CXXIII

VIBRATING HAIRSPRINGS

By Archie B. Perkins, CMW, FNAWCC, FBHI

When selecting and vibrating a hairspring for a watch, the correct vibration that the balance wheel should make must first be determined. If there is no material available that gives this information, the correct number of vibrations per hour is determined by calculating the train of the watch.

Calculating the vibrations per hour that the balance wheel must make for the watch to keep correct time is done in the following manner. Count the teeth in the center wheel, third wheel, fourth wheel, and escape wheel. Multiply the escape wheel teeth by 2. This is done because the balance wheel receives two impulses for each tooth of the escape wheel. Next, count the leaves in the third pinion, fourth pinion, and escape pinion. Then multiply wheel teeth times teeth and pinion leaves times leaves and divide the teeth by the leaves. When we count the teeth and leaves in our example, we have: Center wheel 80, third wheel 70, fourth wheel 60, escape wheel 15, third pinion 10, fourth pinion 8, and escape pinion 7. The following shows an example of how the train is calculated.

FORMULA: $$\frac{T \times T \times 2}{L \times L} = \text{Vibration of Balance Wheel.}$$

Substituting numbers, we would have:

$$\text{Vibrations Per Hour} = \frac{\overset{\text{Center Wheel}}{80} \times \overset{\text{Third Wheel}}{70} \times \overset{\text{Fourth Wheel}}{60} \times \overset{\text{Escape Wheel}}{15} \times 2}{\underset{\text{Third Pinion}}{10} \times \underset{\text{Fourth Pinion}}{8} \times \underset{\text{Escape Pinion}}{7}} = 18{,}000 \text{ V.P.H.}$$

Since the center wheel turns one revolution per hour, the result of the calculation will be vibrations per hour of the balance wheel. If we divide the vibrations per hour by 60, we will get the vibrations per minute. Also, if we divide the vibrations per minute by 60, we will have the vibrations per second.

The train calculation just completed is for a watch that makes 18,000 vibrations per hour. This is the most common vibration for a watch. Other beat trains are shown in Table 1. This table shows trains for watches which have beats from 14,000 V.P.H. to 21,600 V.P.H. Trains are classified as slow, medium, fast, quick, and ultra quick. A slow train is 14,000 to 14,400. A medium train is 15,000 to 17,920. A fast train is 18,000. A quick train is 19,000 to 21,600 beat. An ultra quick train is one which requires a balance wheel and hairspring that vibrates at 28,800 or 36,000. The older antique watches usually vibrate between 14,000 and 18,000 V.P.H. Watches that vibrate above 18,000 are more modern.

The older antique watches usually vibrate between 14,000 and 18,000 V.P.H. Watches that vibrate above 18,000 V.P.H. are more modern.

TABLE 1
WATCH TRAINS

Beats per Hour	Beats per Minute	Center Wheel	Third Pinion	Third Wheel	Fourth Pinion	Fourth Wheel	Escape Pinion	Escape Wheel
14,000	233-1/3	80	12	70	10	70	7	15
14,400	240	64	8	64	8	60	8	15
14,400	240	96	12	90	12	90	12	16
14,400	240	96	12	90	12	75	10	16
14,400	240	80	10	75	10	80	10	15
15,600	260	64	8	60	8	60	6	13
16,200	270	70	8	56	7	54	7	15
16,489-2/7	274-8/10	57	8	54	7	60	6	15
16,800	280	70	8	64	8	64	8	15
16,800	280	80	8	64	8	60	8	14
16,800	280	70	8	64	8	60	8	16
16,900	281-2/3	54	6	52	6	50	6	13
16,925-1/27	282	52	6	52	6	52	6	13
17,010	283-5/10	72	8	64	8	63	8	15
17,160	286	64	8	63	7	55	6	13
17,280	288	54	6	48	6	48	6	15
17,280	288	63	7	56	7	56	7	15
17,280	288	72	8	64	8	64	8	15
17,280	288	72	8	64	8	60	7	14
17,325	288-3/4	64	8	63	8	55	6	15
17,333-1/3	288-9/10	60	6	50	6	48	6	13
17,550	292-1/2	54	6	54	6	50	6	13
17,920	298-2/3	70	8	64	8	64	7	14
18,000	300	54	6	50	6	48	6	15
18,000	300	60	6	48	6	45	6	15
18,000	300	80	10	80	10	75	8	15
18,000	300	75	8	64	8	64	8	15
18,000	300	75	8	64	8	60	8	16
18,432	307-2/10	72	8	64	8	64	8	16
18,850	314-2/10	58	6	54	6	50	6	13
18,900	315	64	8	63	8	60	6	15
19,600	326-2/3	80	10	70	10	70	6	15
19,800	330	80	10	72	8	55	6	15
19,800	330	66	8	64	8	60	6	15
19,825	330-4/10	61	6	54	6	50	6	13
20,020	333-2/3	56	6	55	6	54	6	13
20,250	337-1/2	54	6	54	6	50	6	15
21,450	357-5/10	66	8	60	6	60	6	13
21,600	360	80	8	72	8	64	8	15
21,600	360	64	8	60	6	54	6	15
21,600	360	60	6	54	6	48	6	15

Equipment Used for Vibrating Hairsprings

The equipment used for vibrating hairsprings can range from the most simple to more complicated. The equipment used by the watchmaker is usually quite simple; whereas, the equipment used in the modern watch factories is more complicated. Most of the equipment used in watch factories for vibrating hairsprings is electronic.

The hairspring vibrator that is shown in Figure 1 was used in watch factories years ago before the electronic age and is still used by the watchmaker at the bench. Specialists doing hairspring vibrating for the trade may also use this vibrator in some cases. This vibrator has a master balance wheel and hairspring encased in a container mounted on the table of the vibrator. This master balance is the timing source for the balance and hairspring being vibrated. The disadvantage of this method is that there needs to be a different master balance unit for each vibration encountered. This would be very expensive to have a master balance for each of the many watch vibrations. However, the vibrator can be used for 18,000 V.P.H. balance wheels since most of the watches made have been in this category. A few other master balances could be added for use in vibrating other popular balance frequencies such as 14,400, 16,200, 19,800, and 21,600.

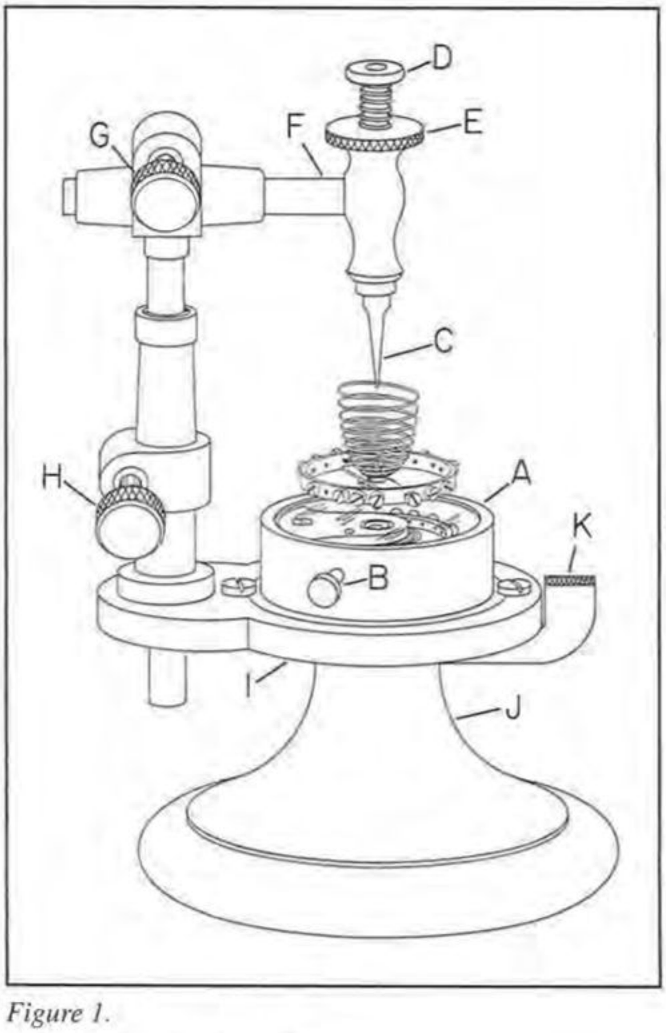

Figure 1.

This method of vibrating hairsprings is called the comparison method. That is, we are comparing a trial balance and hairspring to a master balance which is timed to a given frequency.

Vibrating a Hairspring by the Comparison Method

A description of the vibrator shown in Figure 1 is as follows. View A shows the master balance unit. This unit is held on the vibrator table by two or three screws. A glass covers the master balance. This glass supports the lower pivot of the balance being vibrated. View B shows the spring loaded button used to stop the master balance from moving. View C shows the tweezers for holding the hairspring. View D shows the spring loaded shaft and button that is pressed to open the tweezers. View E shows the knob that is used to turn the tweezers in the housing of the arm F. The tweezers are turned to locate the balance being vibrated exactly over the master balance wheel. View G shows the knob used to move arm F back and

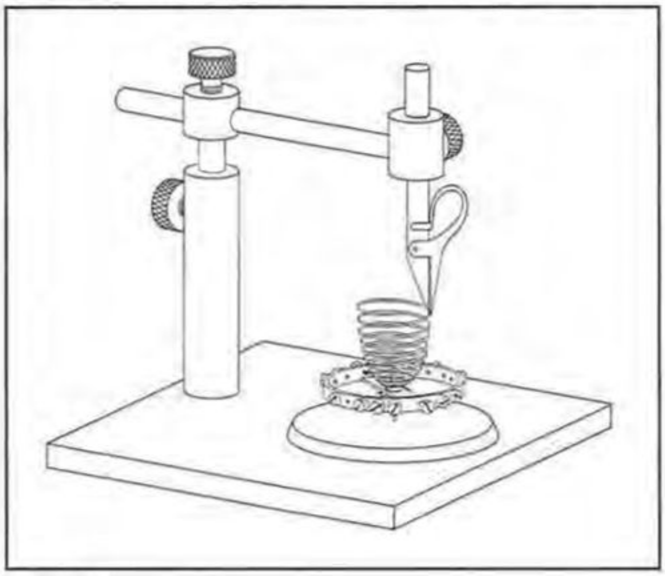

Figure 2.

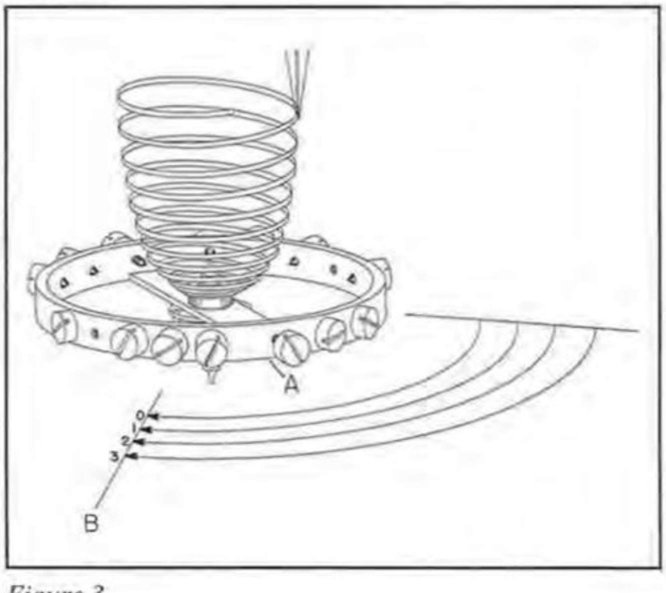

Figure 3.

forth in its housing for locating the balance being vibrated over the master balance. View H shows the knob used for raising or lowering the tweezers holding the hairspring of the balance being vibrated. View I shows the table of the vibrator. View J shows the base of the vibrator. The table of the vibrator is free to turn on the base of the tool.

View K, Figure 1 shows the lever that is pressed and released to start the master balance and the trial balance at the same time. The lower pivot of the trial balance must be resting on the glass as shown for it to start with the master balance. The trial balance wheel should be located exactly centered over the master balance with the arms of both balances lined up with each other. Then lever K is pressed and released to start the balances.

The balances are observed to determine if they stay in step with each other. If they get out of step, then it must be determined if the trial balance is faster or slower than the master balance. If the trial balance is faster than the master balance, the spring must be lengthened to slow it down. On the other hand, if the trial balance is slower than the master balance, the spring must be shortened in the tweezers. When the arms of the two balances stay synchronized, the trial balance will be timed to the master balance. After the spring has been vibrated, its excess is cut off exactly one-half turn outside the timing point. This gives extra spring to work with when fitting the hairspring to the watch and makes it easy to find the timing point.

Vibrating Hairsprings by the Counting Method

Figure 2 shows a simple hairspring vibrator that can be made up by the watchmaker to be used for vibrating hairsprings by the counting method. A flattop watch crystal is cemented to the base of the vibrator, as shown, for the balance staff pivot to rest on while the vibrating is being done. The balance wheel being vibrated can be started into motion by turning the base back and forth on the bench, or it can be started by using a small watch oiler against one of the balance screws. The vibrations of the test balance are counted and timed with a stop watch or chronograph.

Figure 3 shows how the counting of the vibrations is done. As the balance wheel is vibrating, end "A" of the balance arm is viewed. When the balance arm reaches the end of its excursion at point "B," you would say zero and start the stop watch. Then each time the balance arm reached point "B," you would count 1, 2, 3, 4, and so on until you reached the desired number of counts. On the last number, you would stop the watch. If you reach the proper number of counts before the second hand reaches the proper time, this means that the spring is too short and too fast. The tweezers are repositioned, making the spring longer. On the other hand, if, when we reach the desired count and the second hand of the stop watch has passed the stopping point, this means the spring is too long and too slow. In this case, the tweezers are repositioned, making the spring shorter. The process is repeated until the proper count is made in the required time.

If a hairspring is being vibrated for an 18,000 beat watch, this would mean that the trial wheel should vibrate 300 vibrations per minute. Since we are counting when the balance arm goes in only one direction, then we are counting oscillations or two vibrations. In this case, we should get only 150 oscillations in one minute. At first, we only need to count for 30 seconds which means that we should get 75 oscillations in 30 seconds. After the timing point has been found, the oscillations should be counted for a minute or longer. This is to make sure that the timing point is correct.

Second Method of Timing the Vibrations

Figure 4 shows a second method of timing the vibrations when vibrating a hairspring. When this method is used, the arm of the vibrator is turned 180° so the test balance wheel is suspended over the dial side of a pocket watch which has a second hand. The lower pivot of the test balance should rest on the watch crystal over or near the second hand. If the base of the vibrator is large enough to support the watch, then the watch can be used on the base of the vibrator.

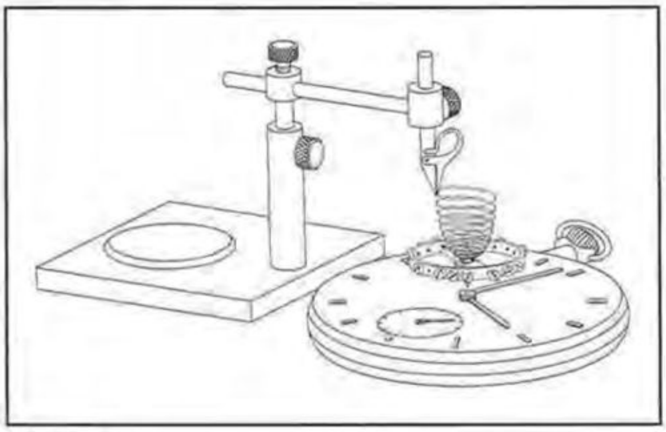

Figure 4.

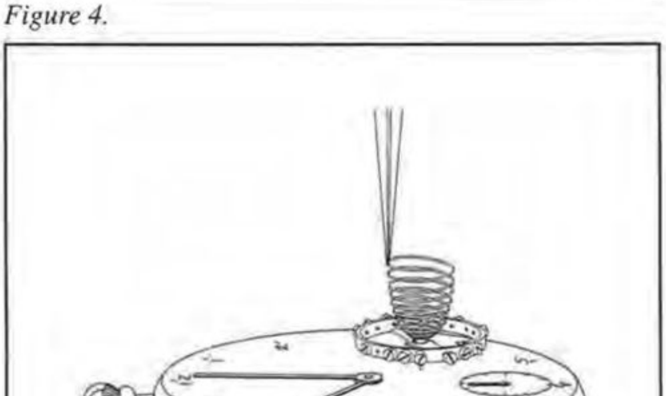

Figure 5.

When starting the count, as the balance arm reaches the end of its excursion at "B," we would say zero. We would keep saying zero at the end of each balance excursion at "B" until the second hand reaches the starting point, saying zero on the starting point, then 1, 2, 3, 4, and so on until the desired count is reached. At this instant, the position of the second hand is checked to see if the test balance has made its vibrations in the correct number of seconds.

Vibrating a Hairspring Without a Vibrator

Figure 5 shows how a hairspring can be vibrated without a vibrator. The balance is suspended over a pocket watch with hand-held tweezers as shown. The balance is turned with the fingers to store up energy in the hairspring and then released to start the balance vibrating. The counting is done in the same manner as in the previous example.

Using the Watchmaster Hairspring Vibrator

Figure 6 shows a Watchmaster hairspring vibrator which was made by American Time Products, Inc. about 1950 as an attachment to be used with their Models G7 and G11 watch-rate recorders. This hairspring vibrator has an electric cord attached which has a special plug that plugs into the Watchmaster where the V3 thyratron tube fits. The tube is removed so the cord can be plugged into the tube's socket. Then, the tube is plugged into the special plug. The vibrator can be left plugged into the machine permanently without affecting the normal use of the machine.

The vibrator has a lead contact plate mounted on top of the table for the lower pivot of the balance wheel to contact at the end of each cycle of oscillation or every other vibration. As the balance and hairspring is being vibrated, the winding and unwinding of the hairspring causes the balance to be raised and lowered. When the balance is lowered, the pivot touches the contact plate and causes the Watchmaster to print a dot on its chart paper. Each time the pivot touches the contact plate, the machine will print a dot on the chart which will make a pattern that is compared with the standard pattern for that beat watch. These standard patterns are shown in the Watchmaster *Handbook*. The balance being vibrated will make one-half as many dots on the chart paper as is shown on the standard chart, but the pattern of dots should be the same as the standard pattern.

How to Time the Hairspring

The timing of the hairspring on the hairspring vibrator is a simple task. From the basic principle of timing odd beat watches as is described in the Watchmaster *Handbook*, the rate of the hairspring being tested can be approximated by the number of lines on the chart.

Count the lines made by the test balance, multiply by

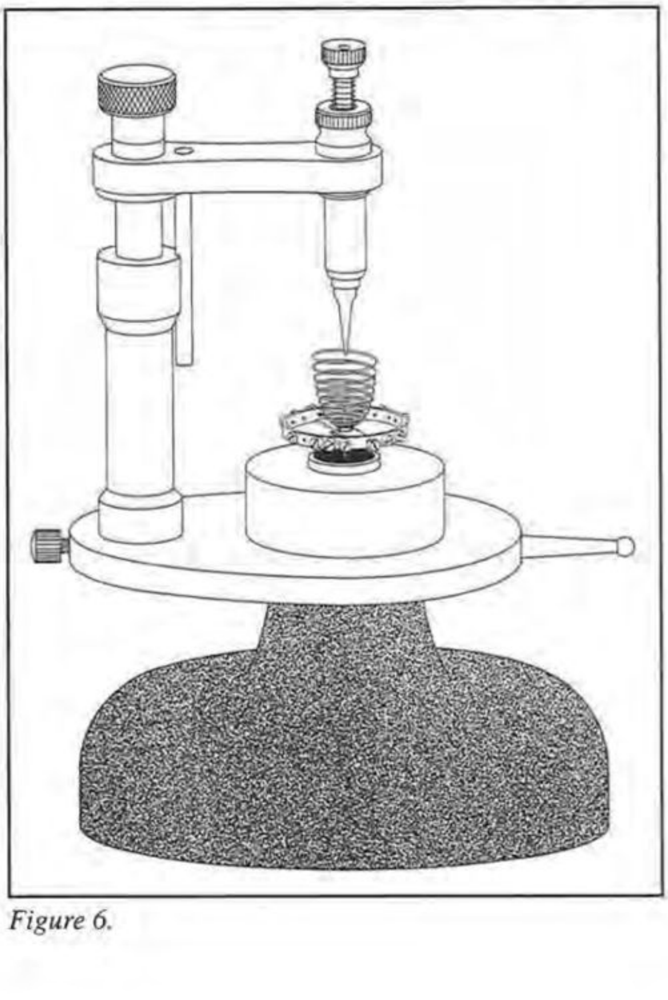

Figure 6.

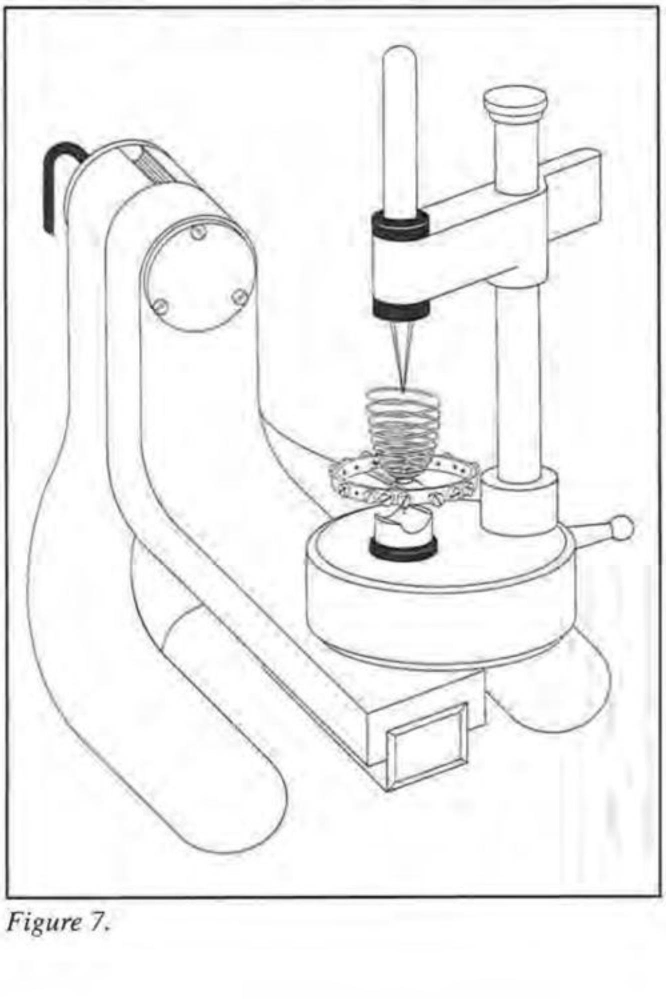

Figure 7.

2, and divide this by the product obtained plus 1. The ratio, always less than unity, will give the approximate rate of the hairspring when multiplied by 18,000. For example, suppose the reading shows six lines. $6 \times 2 = 12$ and $12 + 1 = 13$. Multiply $18.000 \times {}^{12}/_{13}$ and the result is 16615.384.

Now, suppose there are fourteen full turns or coils in the hairspring being tested. Multiply $\frac{14 \times 16615}{18.000} = 12.9$ or about the number of coils there should be in the hairspring.

Using the G47 Watchmaster for Vibrating Hairsprings

The G47 Watchmaster watch-rate recorder has the hairspring vibrating features built into the machine. Figure 7 shows the watch holder of the machine and how it is used for vibrating hairsprings. The balance being vibrated is suspended over the microphone by a pair of tweezers which goes through the hole in a rubber bushing in the arm of the watch holder. The tweezers are adjusted up or down in the bushing so the balance is at the proper height to allow the lower pivot to tap the microphone at the end of each oscillation of the balance. The tapping is picked up by the machine and printed on the chart paper on the drum of the machine. The machine can be set for some odd number vibrations as well as standard vibrations.

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TECHNICALLY WATCHES

ANTIQUE WATCH RESTORATION, PART CXXIV

OVERCOILED HAIRSPRINGS

By Archie B. Perkins, CMW, FNAWCC, FBHI

The main purpose of the overcoiled hairspring is to improve the rate of the watch, especially the isochronal rate. When a watch is isochronal, its rate will be the same with different arcs of motion of the balance wheel. That is, when the mainspring is fully wound and the motion of the balance wheel is the greatest, the time will be the same as when the mainspring is almost run down and the arc of the balance wheel is very small. The time should not be affected by the degree of the arc of motion of the balance wheel whatever it may be.

Isochronism and the Flat Hairspring

Due to the nature of the flat hairspring, isochronism cannot be accomplished. This is because the center of gravity of the flat hairspring continually shifts during the breathing of the hairspring. The flat hairspring can be adjusted so that when it is at rest in the watch, its center of gravity is on center with the balance staff pivot. However, as the balance wheel starts moving and the hairspring expands and contracts, its center of gravity shifts away and toward the regulator pins. This is shown in Figure 1. View A shows a flat hairspring which is at rest or unstressed. In this state, it could be centered so the balance staff would stand in the center of its jewel holes without exerting any side pressure against the side of the jewel holes.

View B, Figure 1 shows the same hairspring in an expanded condition (unwound). Note that the coils opposite the regulator pins are wider apart than the coils on the side next to the regulator pins. This shifting of the body of the hairspring causes its center of gravity to shift from the center of the balance staff pivot toward the wide spaced coils and away from the regulator pins.

View C, Figure 1 shows the same flat hairspring which is in a contracted (wound) state. Note that the coils opposite the regulator pins are closely spaced. In this case, the center of gravity of the hairspring will shift toward the regulator pins on the same side as the regulator pins. This shifting of the center of gravity prevents a close isochronal rate. If a close isochronal rate is expected, the center of gravity of the hairspring must remain on the center of the axis of the balance staff. This can only be achieved with an overcoiled hairspring.

Isochronism and the Overcoiled Hairspring

The overcoiled hairspring was patented in 1779 by John Arnold (1735-1799) for his cylindrical chronometer hairsprings. An overcoil was applied to the flat spiral hairspring by Abraham Louis Breguet (1747-1823) some time after its invention by Arnold. The flat spiral with its overcoil is often referred to as a Breguet hairspring. The overcoil at this time was made and shaped so it gave the proper results without much thought of mathematical calculations. It was not until around 1858 that Edouard Phillips

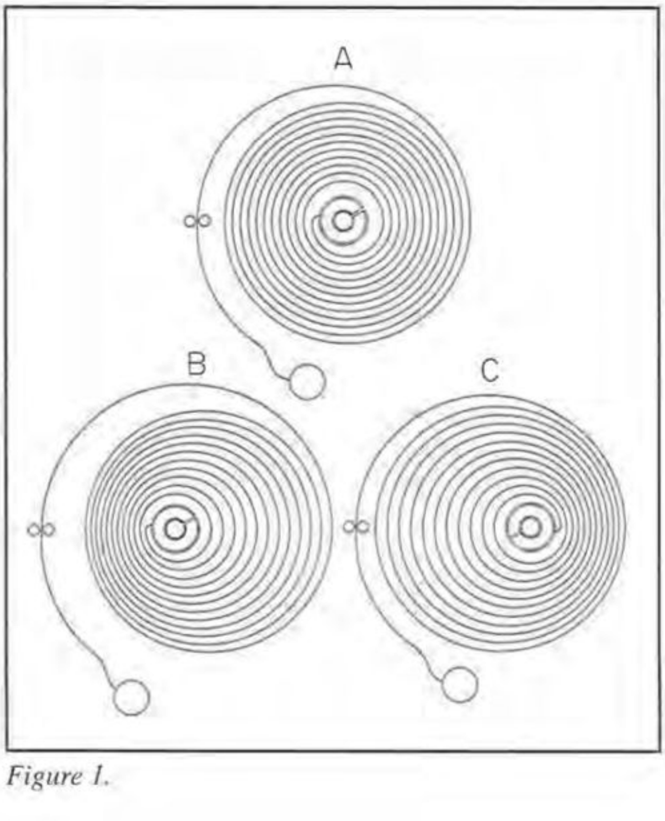


Figure 1.

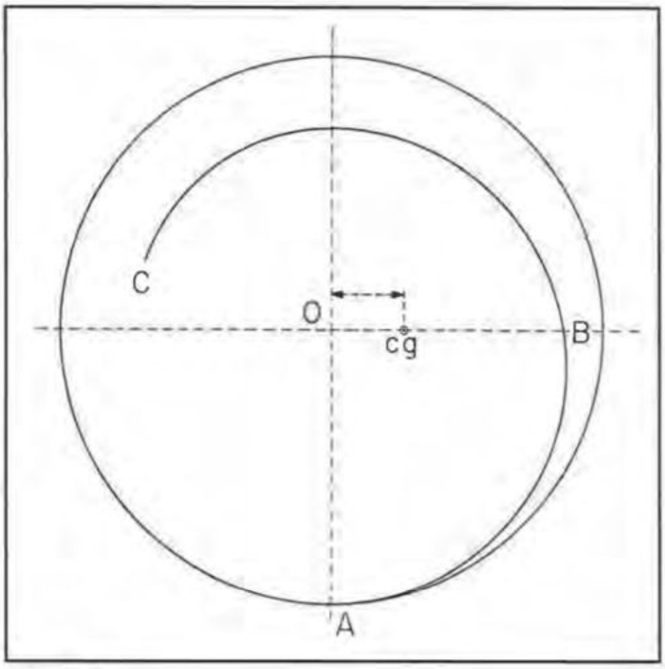


Figure 2.

(1821-1889), a mining engineer who specialized in metallurgy and springs, was asked to do a mathematical investigation of hairsprings. Phillips investigated mathematically the correct shapes of overcoils for hairsprings to cause them to expand and contract concentrically. This concentric development assures a close isochronal rate.

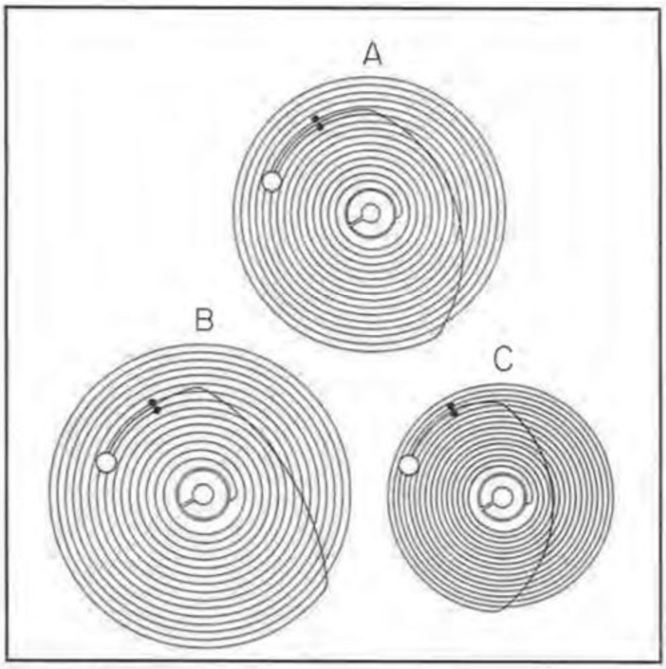


Figure 3.

The work of Phillips was published in the 1860s. Figure 2 is used to illustrate the Phillips theory of the overcoil. View O is the center of the hairspring. The distance ABC is the length of the overcoil, and cg is the center of gravity point.

The Phillips theory is:

1. The center of gravity of the curve should fall on line OB which is a right angle to line OA that goes through the beginning of the terminal curve.
2. The distance from the center of gravity (cg) to the center of the spring must be equal to the radius of the spring squared, divided by the length of the curve.

$$\text{Then, cg} = \frac{OA^2}{ABC}$$

A terminal curve (overcoil) can be any shape as long as the center of gravity of the curve is at the correct position. When the overcoil is made theoretically correct, it may need to be changed slightly to fit the watch and to cause the hairspring to develop concentrically when the watch is running. A hairspring must breathe evenly in all radial directions for the center of gravity to be on the center of the axis of the balance staff. Only when this even breathing is present can we expect a close isochronal rate from a watch.

The overcoil must be formed with the least possible amount of bending. Otherwise, there will be stiff places and weak places in the overcoil which could affect the action of the hairspring even though the overcoil is at the correct place.

Figure 3 is used to illustrate how an overcoiled hairspring should act in the watch when the overcoil is made and adjusted correctly. View A shows an overcoiled hairspring which is at rest (unstressed). View B, Figure 3 shows the same hairspring in an expanded (unwound) position. Note that all of the coils are wider apart but are still evenly spaced. View C, Figure 3 shows the same hairspring in a contracted (wound) position. Note that the coils are closer together but still evenly spaced. This example shows that the hairspring is breathing evenly or expanding and contracting in an even manner. This indicates that the center of gravity of the hairspring is on the center of the axis of the balance staff. With this condition, we should have a close isochronal rate.

Figure 4 shows extreme hairspring conditions and how to adjust an overcoil for isochronal purposes. View B shows a hair-

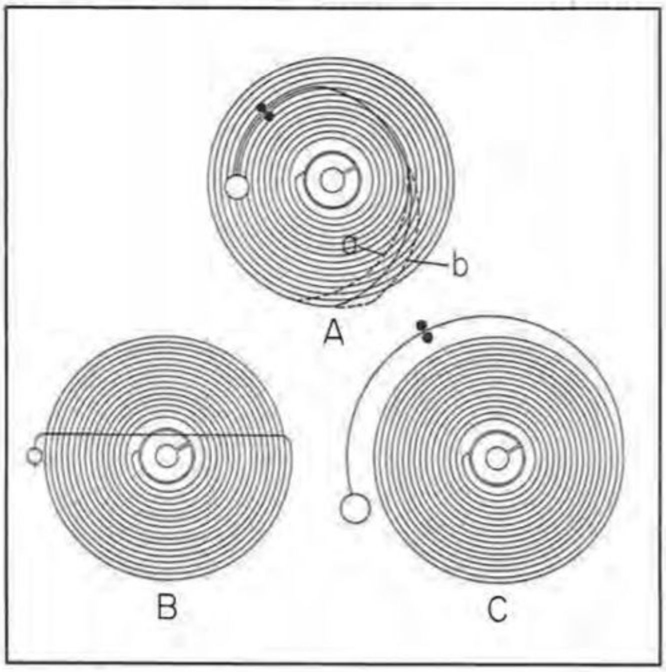


Figure 4.

spring with an extreme overcoil. This overcoil causes the short arcs of the balance wheel to be faster than the long arcs. An extreme overcoil like this causes the hairspring to breathe toward the hairspring stud or regulator pins if the watch has regulator pins.

View C, Figure 4 shows the other extreme in hairsprings. This is a plain flat hairspring which breathes to the side opposite the regulator pins. This condition causes the short arcs of the balance wheel to be slower than the long arcs.

View A, Figure 4 shows how to change an overcoil when adjusting the watch for isochronism. Any changes should be made to the first half of the overcoil. When the overcoil is shaped as shown in solid line and the watch is not isochronal, the following changes can be made to the overcoil. Suppose the short arcs of the balance wheel are faster than the long arcs. This would indicate that the overcoil is too long or the first half of the coil is too close to the balance staff. For major adjustments, the overcoil would be shortened by putting some of the overcoil back into the body of the spring as shown at "b" in View A, Figure 4 to slow down the short arcs. For minor adjustment, the first half of the coil is moved away from the staff without shortening the overcoil.

If the short arcs are slower than the long arcs, the overcoil is made longer or moved toward the balance staff as shown at "a," View A, Figure 4.

Shapes of Overcoils

After Edouard Phillips worked out the theory of the isochronal overcoil, others were involved in the design of overcoils. About 1890-95, Jules Grossmann (1829-1907) and his student Louis Lossier worked on the theory of overcoils and inner terminal curves at the hairspring collet. During this time, Louis Lossier designed an overcoil that has been used universally over the years. This overcoil is shown in Figure 5.

The design of the Lossier overcoil is simple and easy to re-

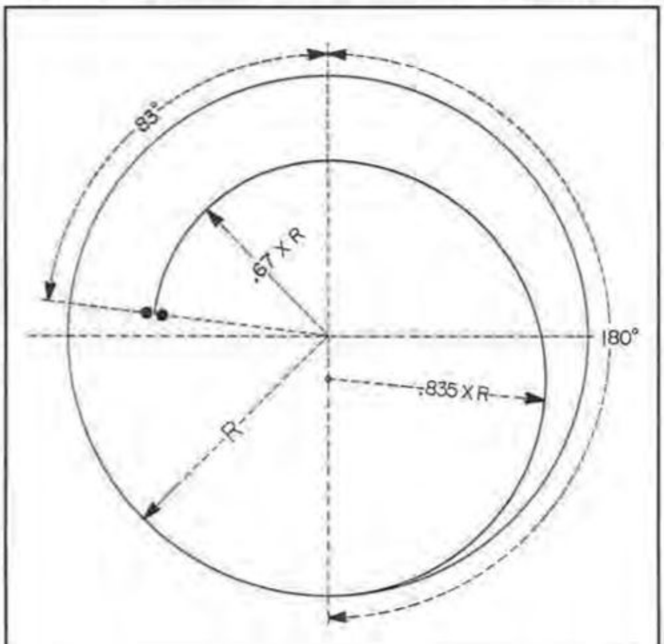


Figure 5.

Plate 1. Left Overcoils.

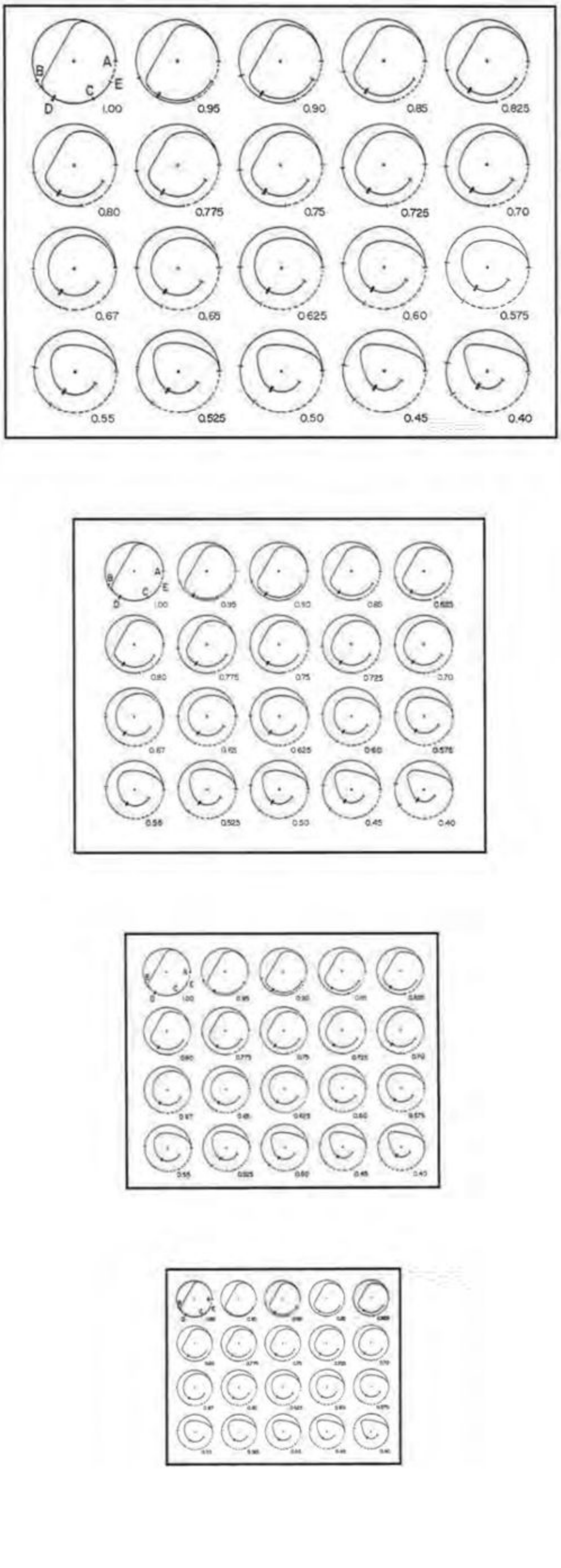
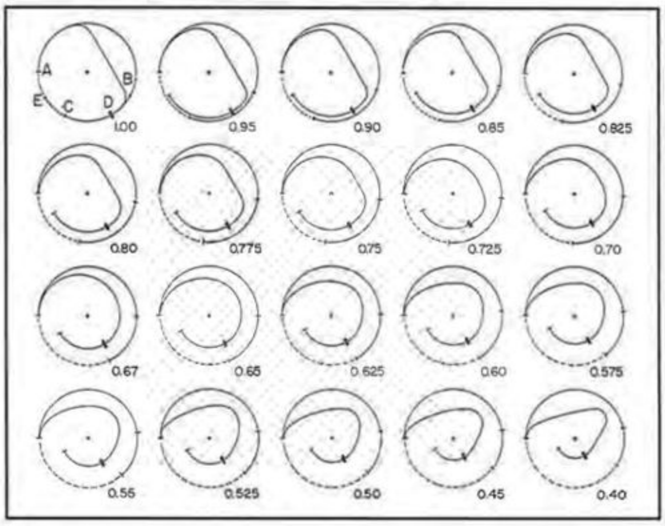
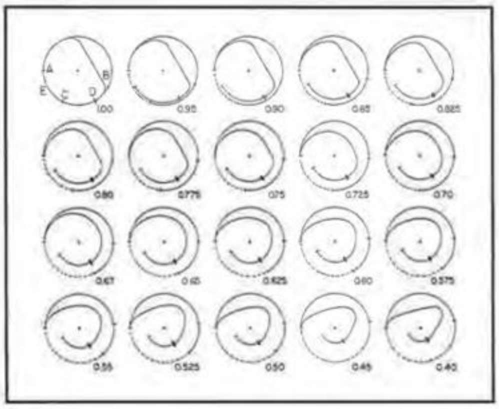
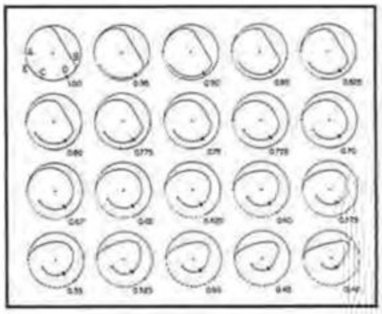
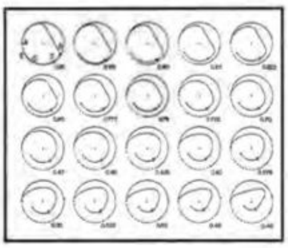


Plate 2. Right Overcoils.









produce because the overcoil is made up with only two curves that can be drawn with a drawing compass. The following is a description of the Lossier overcoil. The first 180° of the overcoil is drawn with a radius that is .835 X R (radius of spring). The last part of the coil, which is the regulator sweep part that ends at the regulator pins, is drawn with a radius of .67 X R. This section joins the first part of the curve and extends for 83°. Then, of course, the regulator sweep is extended enough to reach the hairspring stud. This extension was not used when calculating the shape of the overcoil. This overcoil was designed for a timepiece without regulator pins but it works equally as well with regulator pins.

Overcoil Patterns

The following overcoil patterns were drawn based on the coordinate tables in a book titled *Le Reglage De Precision* by C. Billeter. There are twenty patterns for left overcoils and twenty patterns for right overcoils. These patterns have been reduced in size in order to accommodate different diameters of hairsprings. They can be reduced still further if there is a need. These patterns range from a 100% regulator pins distance from center to a 40% regulator pins distance. It is very difficult to draw these patterns to exactness, but if an overcoil is turned to one of these patterns, you will be within the ball park, so to speak. Some final adjusting may need to be done in the watch afterward. When referring to the overcoil patterns, the following is an explanation of the different position points on each pattern. View A shows the start of the overcoil. View B shows the position of the regulator pins on the outside coil before making the overcoil. View C shows the posi-

Table 1.

Table of Polar Coordinates for Terminal Curves
Curve No. 3 0.90
Regulator Pins Distance = 0.90 X Radius of Spring

Angle of Degrees	Radius Vectors
0	1
15	0.99
30	0.985
45	0.975
60	0.96
75	0.94
90	0.87
105	0.68
120	0.565
135	0.51
150	0.495
165	0.52
180	0.58
195	0.71
210	0.89
225	0.90
240	0.90

Curve Development = 200° 30"

tion of the end of the spring before the overcoil is made. View D shows the actual position of the regulator pins, and View E shows the end of the hairspring after the overcoil is made. (See Plates 1 and 2.)

Making an Overcoil Pattern

Figure 6 shows how an overcoil pattern can be made by the use of the tables of coordinates. First, a circle is drawn. Then, the circle is divided into 15° sections. Next, the degree lines are numbered starting with zero at the line where the overcoil starts leaving the body of the spring. Next, we start plotting the shape of the overcoil by using the figures in the table of coordinates. We have selected curve number 3 which has a .90 regulator pins distance. (See Table 1.) The table shows that for each 15° line there is a radius vector number that is multiplied by the radius of the circle representing the hairspring. This results in a radius point for the position of the overcoil at this particular radius line. The following is an example. The 15° line has a number of .99 mm. If we have a radius of 70.00 mm, then .99 X 70.00 mm = 69.3 mm. Then a mark is made on the 15° line which is 69.3 mm from the center of the circle. Now, we go to the 30° line and calculate this distance. The table shows that for the 30° line we have the number .985. Then, .985 X 70.00 = 68.95 mm. We now make a mark on the 30° line which is 68.95 mm from the center of the circle. This process is continued on each line until the overcoil points are plotted. Then, the overcoil is drawn in through the points made on the degree lines.

The length of the overcoil measured on the outside circle from its start to the regulator pins position is 200° 30" or 200.5° for this particular overcoil. While forming this overcoil, the regulator pins position moves through an angle of 39° 30" or 39.5°.

"Antique Watch Restoration" will continue next month.

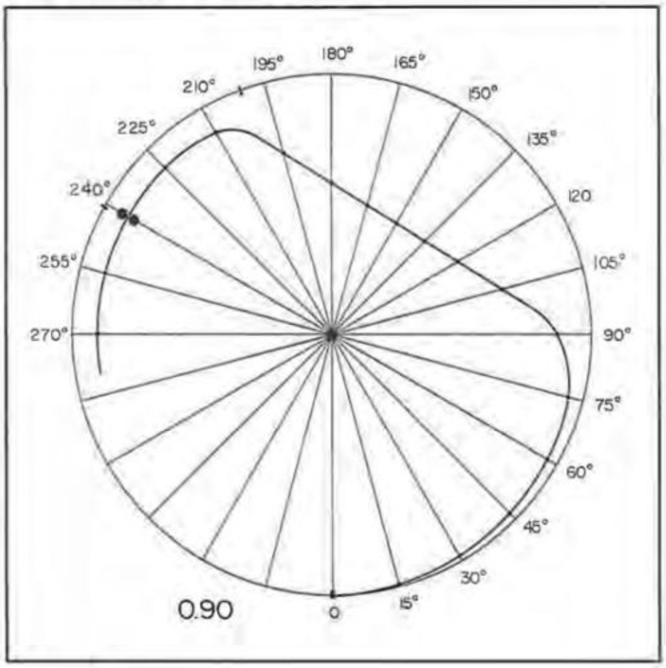


Figure 6.

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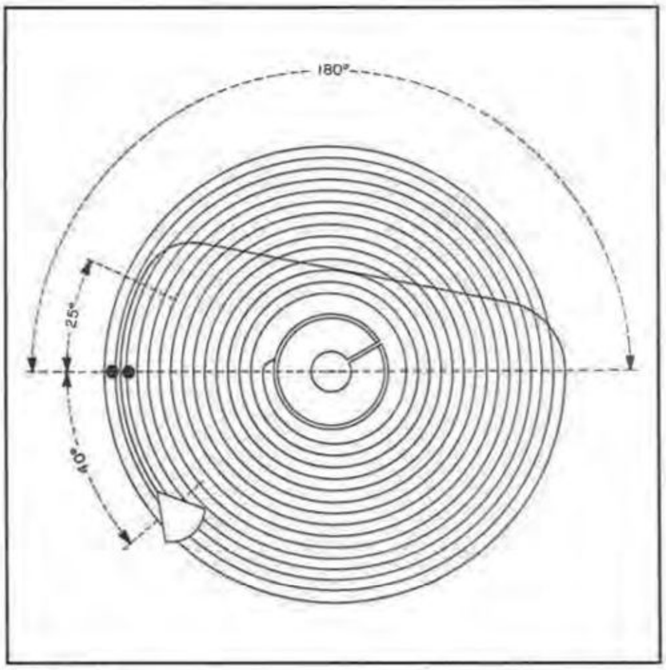

Figure 1.

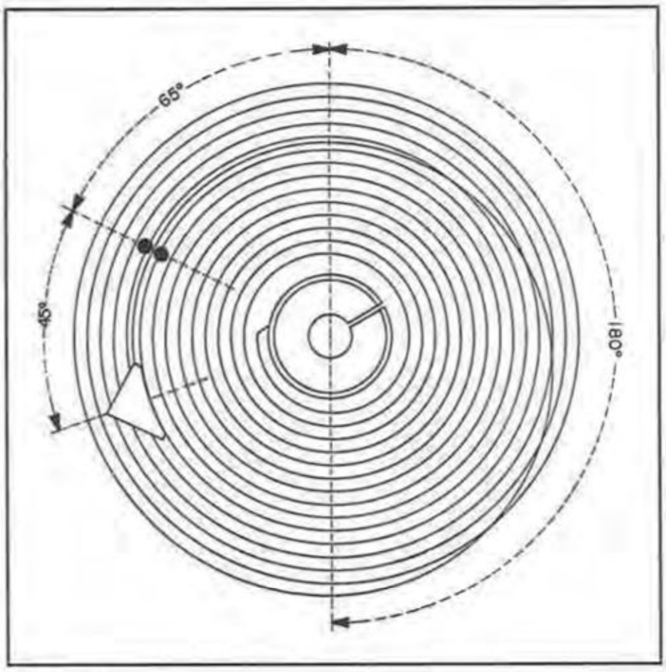

Figure 2.

TECHNICALLY WATCHES

ANTIQUE WATCH RESTORATION, PART CXXV

MAKING OVERCOILS ON HAIRSPRINGS

By Archie B. Perkins, CMW, FNAWCC, FBHI

Different watch companies have their own particular design of overcoil or overcoils. In many cases, these designs are chosen to fit their particular watch designs. Although some of these overcoil shapes do not match any of the patterns shown in the plates of patterns, they still fulfill the requirements of the Phillips theory on overcoils and can be made isochronous.

Some examples of overcoils used by some of the major watch companies follow. Figure 1 shows a style of overcoil that has been used by the Elgin Watch Company. This style of overcoil is sometimes referred to as a double-quadrant overcoil. This is because the two bends in the overcoil are the quarter part of a circle. This style of overcoil is sometimes used in watches when the center wheel is in a position that interferes with the overcoil. The straight part of the overcoil is placed so that it clears the edge of the center wheel.

The Elgin overcoil is designed with a gradual rise bend to raise the overcoil. The rise starts 90° back of the point where the overcoil starts over the body of the hairspring. The angular distance between where the overcoil starts across the body of the hairspring and the position of the regulator pins is 180°. The angular distance from the regulator pins to the stud is 40°. The angular distance from the regulator pins to the second curve in the overcoil is 25°.

Figure 2 shows a Waltham overcoil. This is a circular type of overcoil similar to the Lossier overcoil. The rise in this overcoil is in the form of a knee bend. The knee bend starts about 5° before the overcoil starts over the body of the hairspring. This overcoil is made of two radii. The first radius forms the overcoil for the first 180°. The second radius forms the regulator sweep. The angular distance from the 180° mark to the regulator pins is 65° and the angular distance from the regulator pins to the stud is 45°.

Figure 3 shows a Hamilton overcoil. This overcoil was used in their 950E, 992E, 998, and 999 models. The rise in this overcoil is a knee bend that starts about 30° before the overcoil starts over the body of the hairspring. It is 190° from the start of the overcoil to the regulator pins and 80° from the regulator pins to the stud. The stud is a collar button style of floating stud.

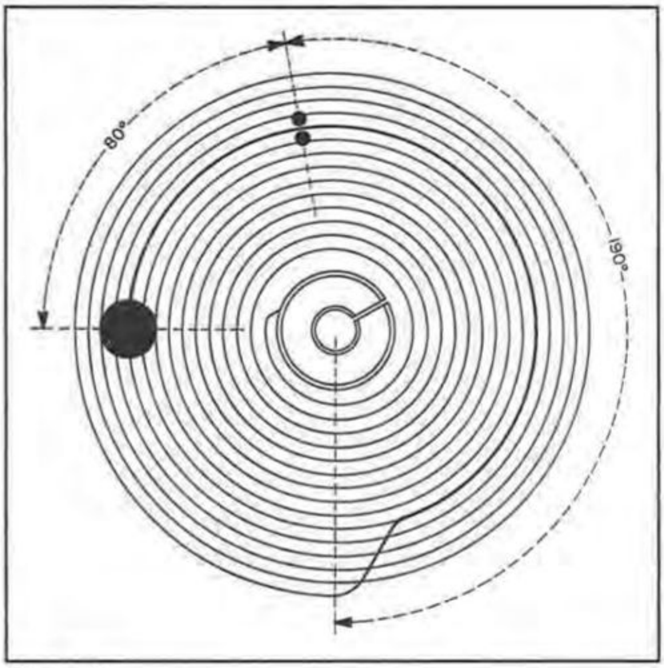

Figure 3.

Figure 4 shows three other Hamilton overcoils. These are all circular-type overcoils. View A shows the 992B overcoil. This overcoil has a knee bend rise which starts about 45° back of the point where the overcoil starts across the hairspring. The height of the knee bend is .43 mm. The angular distance between where the overcoil starts and the regulator pins is approximately 196°, and the angular distance between the regulator pins and the hairspring stud is approximately 54°. This overcoil is also used for models 950B, 998B, 999B, and 4992B. This hairspring has a counterpoised collet.

Figure 4, View B shows the overcoil for 10-size Model 923 Hamilton. The angular distance between the start of the overcoil and the regulator pins is 180°, and the angular distance between the regulator pins and the stud is 55°. This overcoil is raised with a gradual rise bend.

Figure 4, View C shows the 21/0-size Model 721 overcoil. The angular distance between the start of the overcoil and the regulator pins is approximately 134° and between the regulator pins and the stud is approximately 70°. This overcoil is raised with a gradual rise bend.

Figure 5 shows three additional Hamilton overcoils. These overcoils are of the double-quadrant style with very little radius to the bends at the ends of the straight part of the overcoil. View A shows the 6/0-size Model 987A overcoil. The angular distance between where the overcoil starts across the spring and the second bend is 113° and from this point to the stud is 108°. The distance from the stud to the regulator pins is 70°. This overcoil is raised with a gradual rise bend.

View B, Figure 5 shows the 14/0-size Model 980 overcoil. The angular distance between the start of the overcoil and the second bend is 120°, and between the second bend and the stud, the angular distance is 130°. The angular distance from the stud to the regulator pins is 80°. The overcoil has a gradual rise bend.

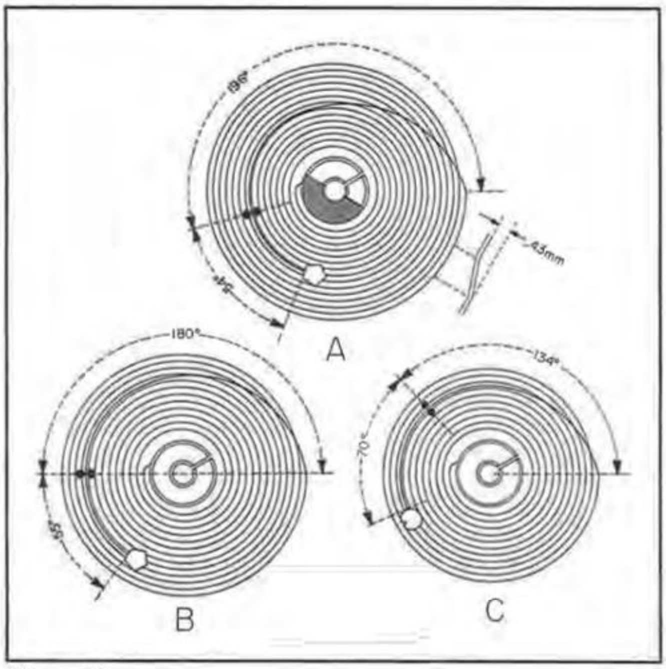

Figure 4.

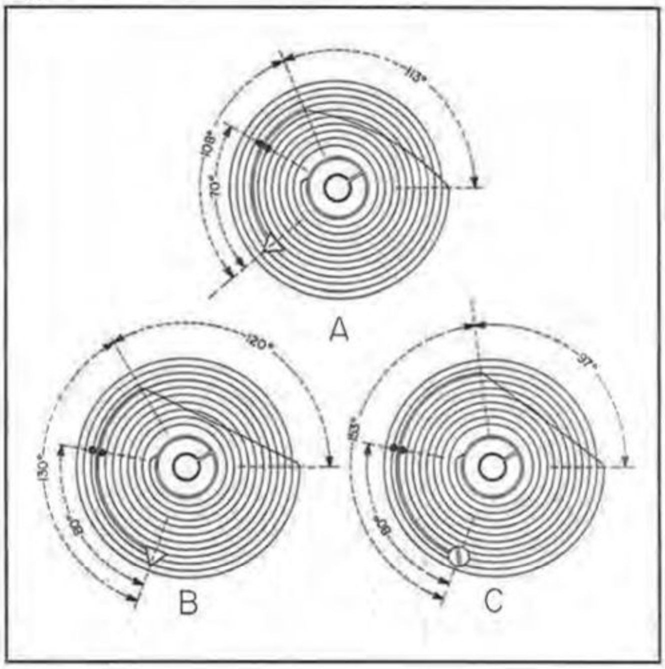

Figure 5.

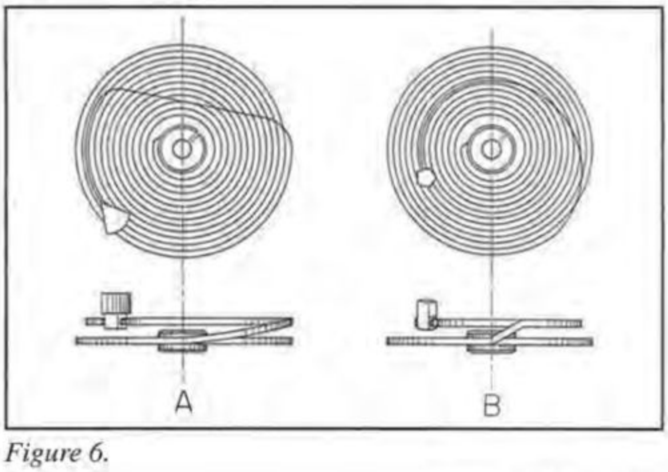

Figure 6.

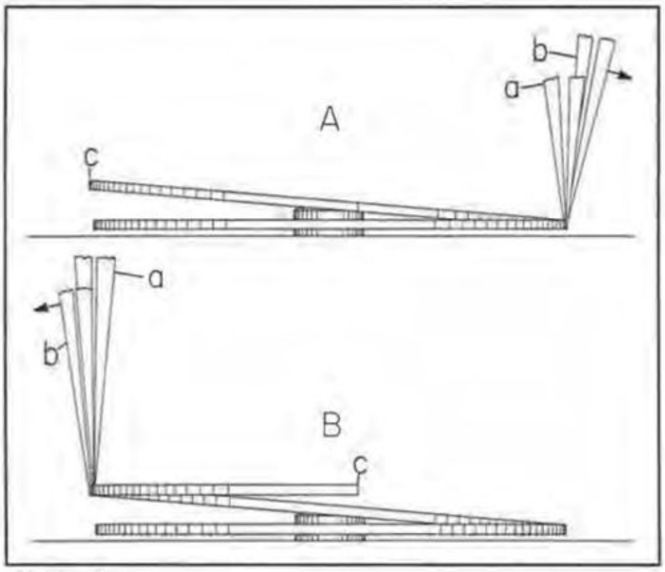

Figure 7.

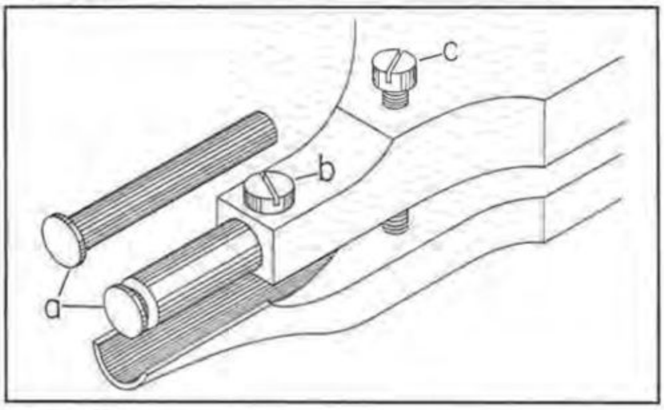

Figure 8.

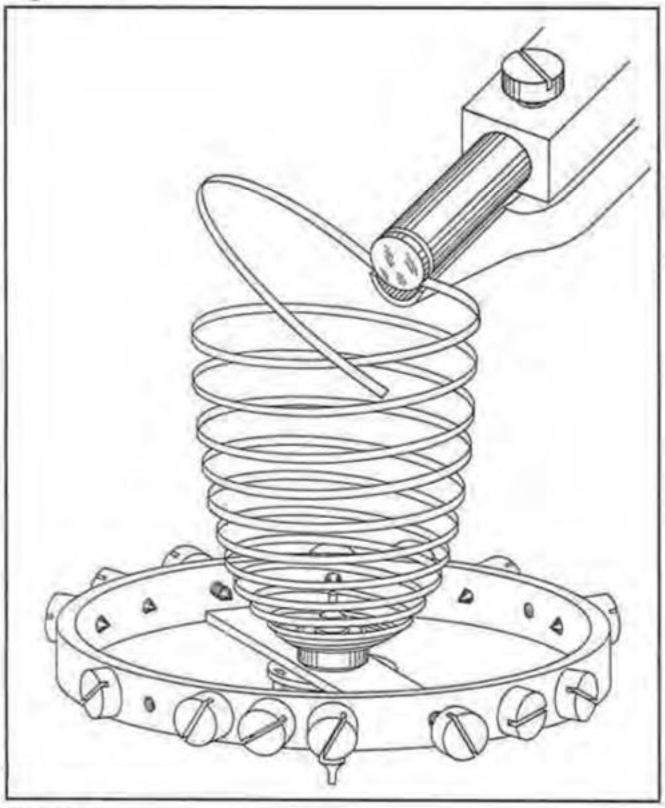
Figure 9.

View C, Figure 5 shows the 20/0-size 987 overcoil. The angular distance between the start of the overcoil and the second bend is 97° and between the second bend and the stud is 153°. The angular distance between the stud and the regulator pins is 80°. This overcoil has a gradual rise bend.

Two Styles of Overcoil Rise Bends

Figure 6 is used to show the two styles of bends for overcoils. View A shows the gradual rise bend. The gradual rise bend starts 90° back of where the overcoil starts across the body of the hairspring. This bend is made with two tweezers. The gradual rise bend is usually used when there is very little space for an overcoil.

View B, Figure 6 shows the knee bend rise. This bend is made within an area between where the overcoil starts across the hairspring and a point 45° back of this position. The knee bend is a double bend. The first bend raises the coil and the second bend levels the coil to the desired height. The knee bend rise is usually used when there is adequate to excess space for an overcoil.

Making the Gradual Rise Bend

Figure 7 shows how the gradual rise bend is made. View A shows the first bend being made to raise the overcoil. This is usually done with two tweezers. The outside coil is held at the proper place with tweezers "a" while tweezers "b" are leaned in the direction of the arrow to raise the coil. The coil is raised to the maximum height at "c" which is opposite the point where it is manipulated with the tweezers.

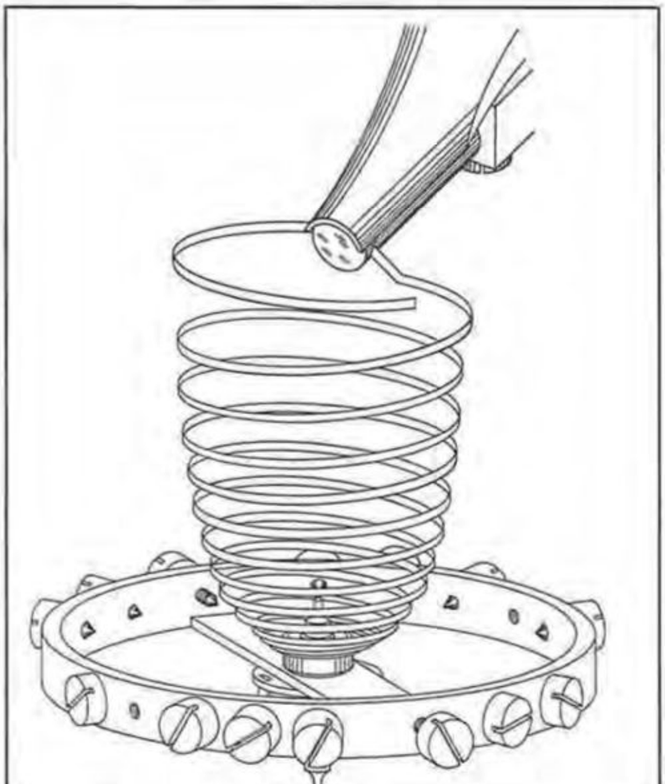
Figure 10.

View B, Figure 7 shows the second bend used in making a gradual rise bend for an overcoil. This bend is made opposite the first bend which raised the coil and is used to level the end of the coil. To make this second bend, the coil is held with tweezers "a" while tweezers "b" are used to level the end of the coil. Tweezers "b" are swung in the direction of the arrow.

Making the Knee Bend

Figure 8 shows special Dumont hairspring overcoiling tweezers. These have been made in four sizes. These sizes are: 0, 1, 2, and 3. Size 0 is the smallest and 3 is the largest. These tweezers are used to form the knee bend when raising the overcoil. Following is a description of the tweezers. The upper jaw of the tweezers has been machined down to form a cylinder at the end of the jaw. A hole has been drilled lengthwise through the center of the cylinder. This hole holds a headed pin "a" that is held in place with set screw "b." The lower jaw has been machined so it has a concave shape to match the shape of the cylinder and pin of the upper jaw. The stop screw "c" is used to control the distance between the two jaws when they are pressed toward each other. The headed pin can be adjusted in or out of the hole for different thicknesses of hairspring material. Once the pin is adjusted for the spring thickness, set screw "b" is tightened to hold the pin stationary.

Figure 9 shows how the tweezers are used to raise the overcoil. The balance and hairspring are suspended by the overcoiling tweezers, as shown, when the bend is made. It is advisable to first set the tweezers stop screw with a scrap piece of hairspring of the same size to avoid overbending the new hairspring.

Figure 10 shows how the overcoiling tweezers are used to level the overcoil after it has been raised. This operation completes the knee bend. For this operation, the tweezers are turned over so the round jaw is below the concave jaw as shown.

Second Method of Making the Knee Bend

Figure 11 shows a pair of tweezers that can be made by the watchmaker for making the knee bend in an overcoil. This tool can be made from an old pair of tweezers or it can be made from flat stock. View A shows the finished tweezers. The inside of the upper jaw has been rounded and the inside of the lower jaw has a rounded slot milled into the surface to match the rounded upper jaw. The lower jaw has four guide pins that are frictioned tightly into holes drilled through the lower jaw. These guide pins are located so they guide the upper jaw of the tweezers to keep it centered with the concave slot of the lower jaw. The guide pins are also spaced close enough so they hold the hairspring material upright while the raise is being made in the overcoil. Stop screw "a" determines the amount of rise given the overcoil.

View B, Figure 11 shows the tweezers being used to raise the overcoil. View C, Figure 11 shows the second bend being made to level the overcoil. When this bend is made, the hairspring is turned over with the top side down.

Third Method That Can Be Used to Make the Knee Bend

Figure 12 shows a simple method that can be used to make the knee bend to raise the overcoil. This method involves the use of a pair of regular tweezers that have been changed slightly for this purpose. View A shows one method of changing the tweezers for making the knee bend. In this case, a step is ground on the inside of one jaw of the tweezers. This step prevents the hairspring from sliding upward between the jaws of the tweezers when the points of the twee-

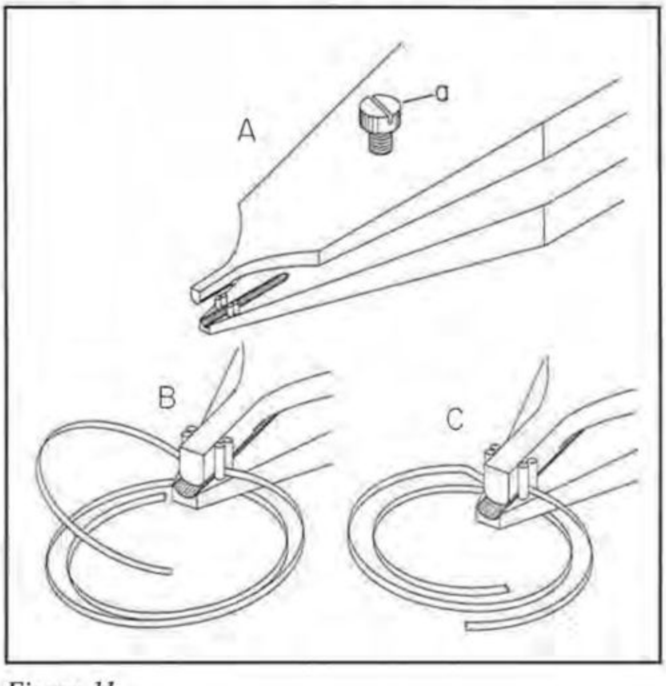

Figure 11.

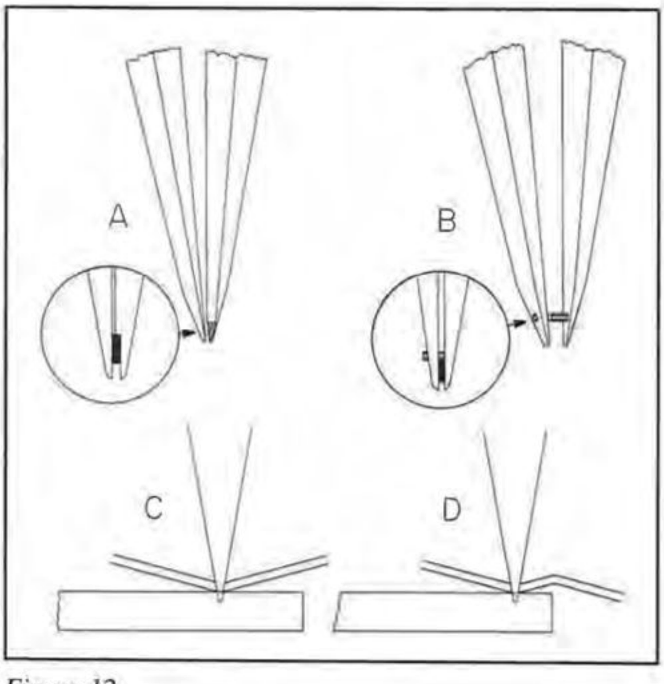

Figure 12.

zers are pressed into wood to raise the overcoil. The inset in View A shows the hairspring material held between the jaws of the tweezers.

View B, Figure 12 shows another method of changing the tweezers for making the knee bend. In this case, instead of making a step in the jaw, the jaws are drilled so a round pin can be frictioned into one of the jaws of the tweezers. The hole in the other jaw will guide the pin and support the pin when the tweezers are used. The hairspring will be supported by the pin and help form the curve of the knee bend when the tweezers are used. The inset in View B shows the hairspring material between the jaws of the tweezers.

View C, Figure 12 shows the tweezers being used to make the first bend to raise the overcoil. The points of the tweezers with the hairspring positioned between them are pressed into a block of soft wood to raise the overcoil.

View D shows the second bend being made to level the overcoil. The hairspring is turned over with top side down when making the second bend to level the coil. Caution: Care must be used to avoid overdoing these operations to prevent the hairspring from being damaged. Much practice work should be done on damaged hairsprings to perfect the method.

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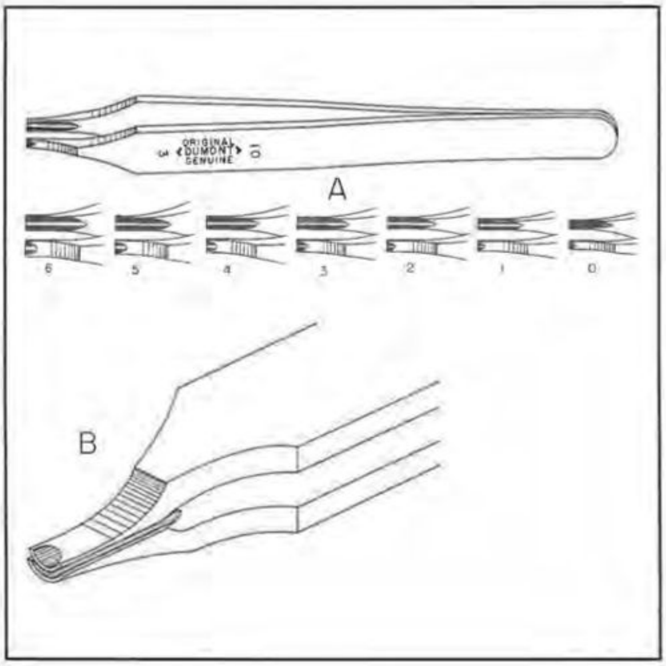

Figure 1.

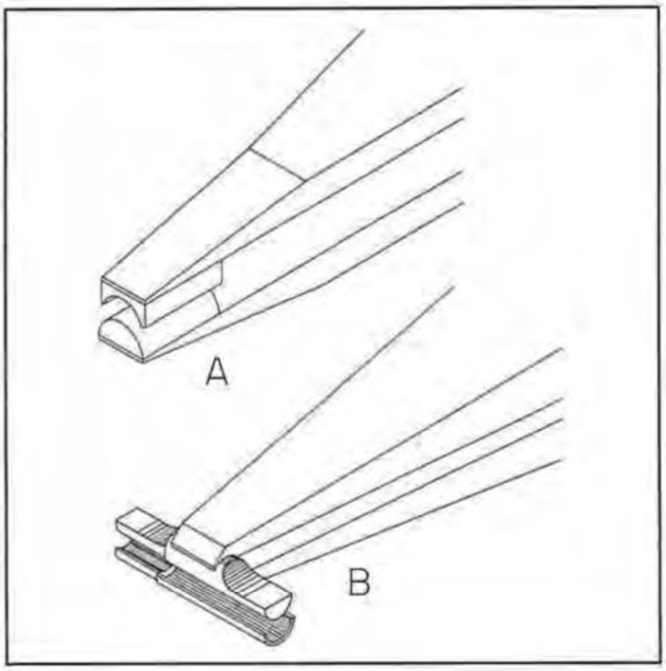

Figure 2.

TECHNICALLY WATCHES

ANTIQUE WATCH RESTORATION, PART CXXVI

MAKING OVERCOILS ON HAIRSPRINGS, PART 2

By Archie B. Perkins, CMW, FNAWCC, FBHI

When forming overcoils that have short radius bends, overcoiling tweezers are needed. Overcoiling tweezers can also be used for forming overcoils that have long radius bends.

Overcoiling Tweezers

Figure 1, View A shows the Dumont overcoiling tweezers. The style of these tweezers is number 10 and they are made in seven different sizes from 0 to 6. Size 0 is the smallest and size 6 is the largest. View B, Figure 1 shows an enlarged three-dimensional view of the overcoiling tweezer points. One point of the tweezers has a concave surface and the other point has a matching convex shape.

Figure 2 shows two additional styles of overcoiling tweezers. These tweezers can be made up by the watchmaker if desired. View A shows overcoiling tweezers that can be made from an old pair of tweezers by soldering a convex block to one jaw of the tweezers and by soldering a concave block to the other jaw of the tweezers. The curvature of both blocks should match. If these jaws are attached to strong tweezers or small pliers, they can be used for making overcoils on chronometer hairsprings.

Many years ago, during a tour through the Elgin Watch Factory, I observed some hairspring workers making overcoils on hairsprings. They were using special overcoiling tweezers similar to the ones shown in View B, Figure 2. The concave and convex jaws were located on the tweezer jaws at right angles to the tweezer jaws as shown. This location allowed two different sizes of overcoiling jaws which enabled the worker to make the two different short radius bends in the Elgin overcoil with the same overcoiling tweezers by just turning the tweezers over in his/her hand. This saved the worker some time because it was unnecessary to lay the tweezers down after making the first bend and pick up another size of tweezers for making the second bend. This allowed the worker to completely make an overcoil in just seconds.

Using Overcoiling Tweezers

Figure 3 shows how overcoiling tweezers are used on hairspring material for altering the shape of the material. View A shows a pair of small-sized overcoiling tweezers used on hairspring material when making a short radius bend in the material. The more the tweezers are closed, the shorter the radius of bend will be.

View B, Figure 3 shows a long radius bend being made with large-sized overcoiling tweezers. Again, the more the tweezers are closed, the shorter the radius of the bend.

View C, Figure 3 shows how large size overcoiling tweezers are used to form a circular section of hairspring material. When this method is used to circle a regulator sweep, for example, it must be done without causing the spring to become kinked.

View D, Figure 3 shows how a hump can be removed from a hairspring with the overcoiling tweezers. The tweezers are reversed on the spring as shown.

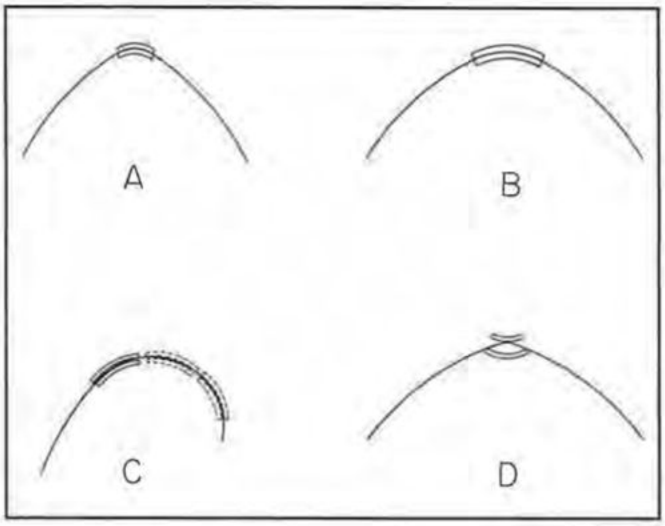

Figure 3.

Forming an Overcoil Using a Template as a Guide

When forming an overcoil, it can be formed on a template that is laid out with the proper degree lines for that particular hairspring. This is done especially if there is no standard overcoil pattern available to turn the overcoil to when forming it to shape.

Forming an Elgin Double Quadrant Overcoil

Figure 4 shows a template for an Elgin overcoil. This is made from an engravers copper practice plate. The design and degree lines are drawn on the plate with a scriber. It is 180° from where the overcoil starts across the body of the hairspring to the regulator pins position. It is 25° from where the regulator sweep starts at the second bend to the regulator pins and 40° from the regulator pins to the hairspring stud. The shape of the overcoil has been drawn in with broken lines just to show the general shape of the overcoil.

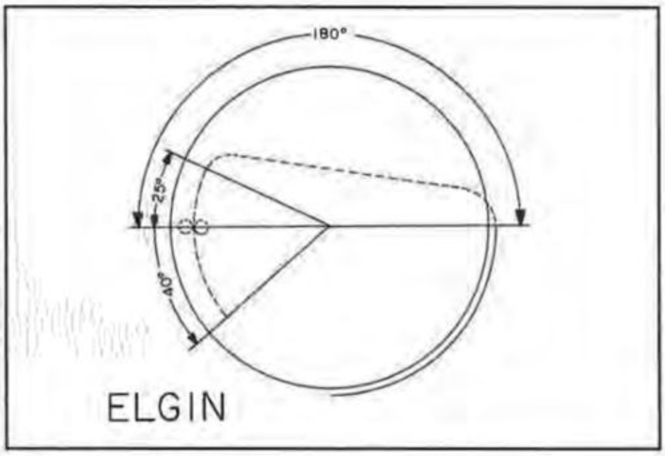

Figure 4.

The actual forming of an Elgin double quadrant overcoil to the template is shown in Figure 5. View A shows how the first bend is made. This bend is made after the outside coil is raised with a gradual rise bend, starting at point "a," 90° before the first bend. The first bend is made at point "b" with the proper size of overcoiling tweezers. This bend is made approximately 140° back of the timing point on the hairspring and the rise is 90° back of the first bend. This places the rise at 230° back of the timing point on the hairspring.

View B, Figure 5 shows how the straight part of the overcoil is formed. To do this, the overcoil is held with a pair of tweezers at point "a" while another pair of tweezers is used to remove the curve in a section of the overcoil. The tweezers used to remove the curve should have rounded and polished surfaces inside the jaws near the points of the tweezers. The worker should grasp the overcoil with the rounded tweezers and slide the tweezers on the overcoil away from the holding tweezers as shown at "b," View B, Figure 5. A slight twisting motion of the tweezers may be necessary in order to straighten out the section of overcoil. Next, the straight section must be lo-

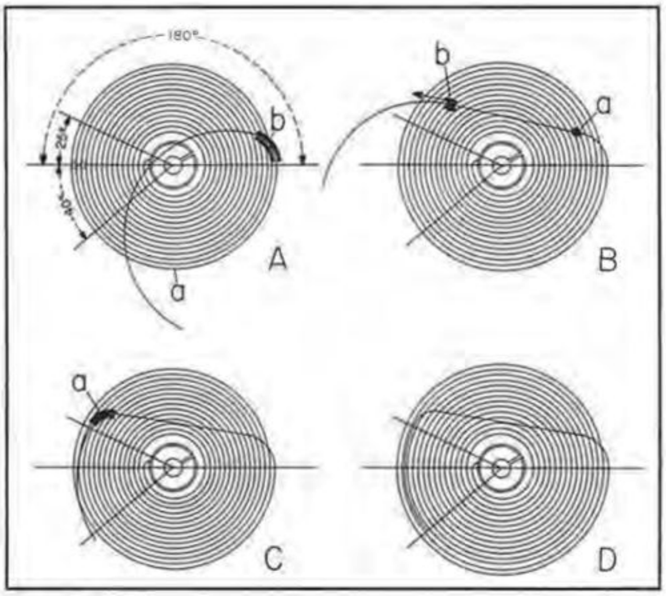

Figure 5.

cated at its proper position across the hairspring. This is done by holding the straight section with the tweezers at point "a," View B, Figure 5. Now, pull out or push in on the straight section near the holding tweezers with a needle until the straight section lies just outside the third coil of the hairspring from the collet. Then, the second bend is made on the overcoil.

View C, Figure 5 shows the second bend being made. Smaller overcoiling tweezers are used to make this bend. This is necessary because the radius of this bend is shorter than is the radius of the first bend.

After the second bend has been formed, the regulator sweep is shaped. This can be done with large overcoil tweezers. The regulator sweep can also be circled by using a pair of tweezers to hold the regulator sweep and a needle or hairspring pin to manipulate the regulator sweep to curve it and place it in the proper position. The regulator sweep is usually positioned midway between the second and third coils on Elgin hairsprings. View D, Figure 5 shows the completed overcoil.

Forming a Double Radius Overcoil to a Template

Figure 6 shows a template for forming a double radius overcoil. The first section of this overcoil is made with a radius that is equal to the radius of the spring at the start of the overcoil. The second section of the overcoil or the regulator sweep is equal to the regulator pins distance from the center of the hairspring. The angular distance between the first bend and the second bend is 155°. The angle between the second bend and the stud is 93°.

Figure 7 shows how to form a double radius overcoil. If it is desired to raise the overcoil with a gradual rise bend, this is done 90° back of where the overcoil starts across the body of the hairspring. On the other hand, if the overcoil is to be raised with a knee bend, this should be done within an angular distance of 45° before the overcoil starts across the body of the hairspring.

View A, Figure 7 shows the overcoil after the first bend is made. The radius of the overcoil is equal to the radius of the hairspring at the start of the overcoil. The first 155° of this radius is left unchanged as part of the overcoil shape. The first bend can be made with a pair of small overcoiling tweezers, or it can be made with rounded jaw tweezers and a needle or brass pin. To use the latter method, the outside coil of the hairspring is held with the rounded tweezers where the overcoil is to start across the body of the hairspring. Then, the needle or pin is used to manipulate the coil inward to form the first bend.

View B, Figure 7 shows the second bend after it has been made. This bend is made 155° from the first bend and is made in the same manner as the first bend.

Next, the regulator sweep is formed. This is shown in View C, Figure 7. The regulator sweep can be circled with a larger size of overcoiling tweezers or with rounded jaw tweezers and a pin. Regardless of which method is used, care must be exercised so the regulator sweep will not have any kinks. The tweezers will need to be used in more than one position while circling the regulator sweep.

View D, Figure 7 shows the completed overcoil after the regulator sweep has been circled and positioned.

Forming a Lossier Overcoil to a Pattern

Figure 8 shows a Lossier overcoil pattern. This pattern is in the table of overcoils shown previously. If desired, Figure 8 can be reduced and used as a pattern. The radius of the first 180° of the Lossier overcoil is .835 x R (radius of spring) and the radius of the regulator sweep is .67 x R. The angular distance from the 180° line to the regulator pins is 83° . The regulator sweep extends beyond the regulator pins to reach the stud's position. The angular distance on the outside coil between the timing point and the point where the overcoil starts across the body of the spring is 205°. If the rise of the overcoil is a

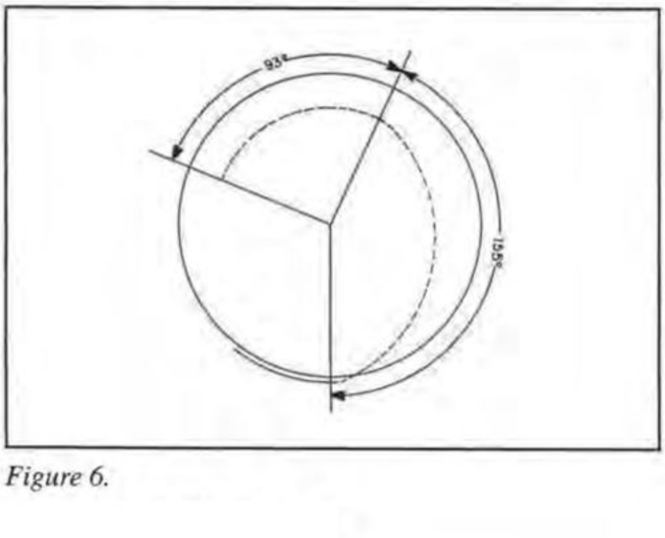

Figure 6.

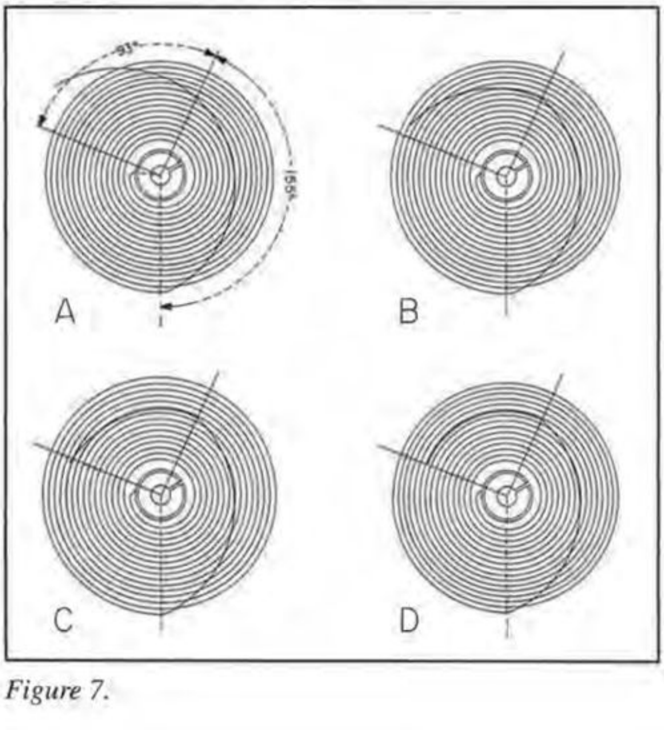

Figure 7.

gradual rise, it should start 90° back of the point where the overcoil starts across the body of the hairspring. If a knee bend is used, it can start just back of where the overcoil starts across the hairspring.

Figure 9 shows how the Lossier overcoil is formed. View A shows how the first bend is made to start the overcoil across the body of the hairspring. A large overcoil tweezer can be used for this bend as long as the bend is not made too sharp. A more gentle way of making the bends in this shape of overcoil is to use rounded jaw tweezers and a round wooden toothpick as shown. The overcoiling tweezers are better for more drastic short radius bends.

To make the first bend, the outside coil is held with the rounded jaw tweezers at "a;" then, the toothpick is used at "b" to manipulate the overcoil so it is the same shape as the overcoil pattern. The hairspring must be centered and lined up when it is checked with the pattern. The toothpick is used on the overcoil at a point where the desired results are gotten. The main idea is to avoid making any sharp bends or kinks in the overcoil.

View B, Figure 9 shows the approximate position of the tweezers for the second manipulation. This is shown at point "a." The toothpick is used at point "b" to manipulate the overcoil inward to make it the same shape as the overcoil pattern.

View C, Figure 9 shows the third manipulation which is used to form the regulator sweep. The overcoil is held at "a" and manipulated inward at "b" to align the regulator sweep with the pattern.

View D, Figure 9 shows the position of the tweezers at "a" and the toothpick at "b" for completing the end of the regulator sweep. After this, the overcoil is rechecked to make sure it is the same shape as the overcoil pattern.

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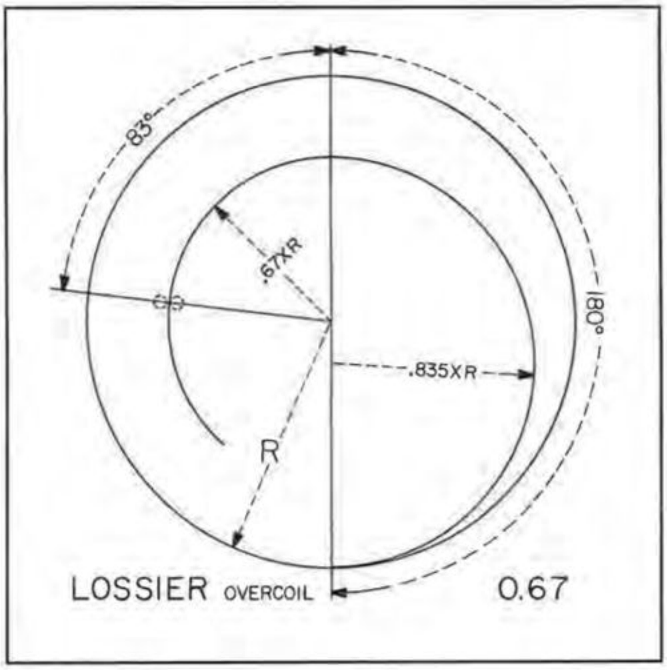

Figure 8.

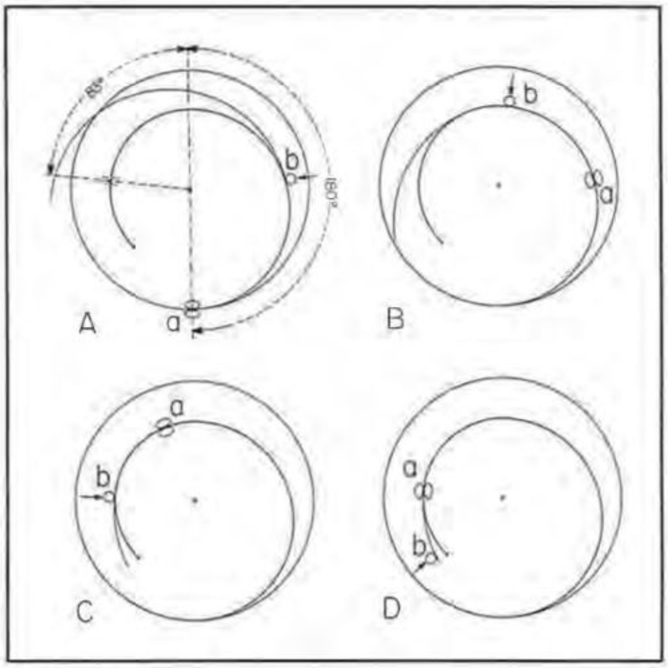

Figure 9.

TECHNICALLY WATCHES

ANTIQUE WATCH RESTORATION, PART CXXVII

TRUING HAIRSPRINGS TO THE BALANCE COCK

By Archie B. Perkins, CMW, FNAWCC, FBHI

Truing hairsprings to the balance cock is done before the hairspring is placed in the watch for final truing. It is done to minimize the amount of truing needed in the watch.

Truing hairsprings to the balance cock consists of three operations: (1) Circling and centering the regulator sweep, (2) Centering the hairspring collet to the balance hole jewel in the balance cock, and (3) Leveling the hairspring to the balance cock. These three operations are done in this order, therefore they will be discussed in this order.

Importance of Regulator Pins' Condition

Before attempting to true a hairspring to the balance cock, it is very important to have the regulator pins in proper condition and position. This is shown in Figure 1.

View A, Figure 1 shows the regulator used for a flat hairspring. This regulator has a key and a pin to control the hairspring. The key is turned one-fourth turn with a screwdriver when removing or replacing the hairspring on the balance cock. The key has a lip extending out to cover the end of the regulator pin to close up the space between the key and the pin. The space between the key and the regulator pin should always be parallel and allow adequate space for the outside coil of the hairspring.

View B, Figure 1 shows a regulator for an overcoiled hairspring. This style of regulator has two regulator pins as well as a key. This style is used by Bulova. The closed key prevents a coil of the hairspring in the body of the hairspring from getting caught between the regulator pins if the watch should get a sudden shock.

View C, Figure 1 shows a regulator for an overcoiled hairspring. This style of regulator is mostly used for overcoiled hairsprings.

View D, Figure 1 shows another view of the regulator pins which shows them lined up with each other. The pins should be straight and at a 90° angle with the regulator.

View E, Figure 1 shows a hairspring that has been bent between the regulator pins and the hairspring stud as the regulator was moved toward the slow side of the regulator scale. This condition was caused by the regulator pins being too tight on the regulator sweep of the hairspring. The regulator pins should always be adjusted so there is adequate clearance on the regulator sweep of the hairspring between the pins.

Shaping the Flat Hairspring at the Stud

The hole in the balance cock for the stud of a flat hairspring is always placed a greater distance from the jewel hole than the distance that the regulator pins are placed from the jewel hole. This practice is to allow clearance between the stud and the second coil of the hairspring when the hairspring is breathing. Since the hairspring stud is farther from the center than the regulator pins, we must shape the hairspring inward at the stud in order to circle the regulator sweep of the hairspring. This is shown in Figure 2.

View A, Figure 2 shows a flat hairspring after it has been pinned at the stud and before it has been shaped at the stud. At this stage, the hairspring needs to be shaped at the stud to allow the regulator sweep to be circled for the regulator pins. Note that the hairspring collet is off-center with the jewel. This is caused by the stud position being farther from center than are the regulator pins.

View B, Figure 2 shows the hairspring after it has been shaped at the stud with a dog-leg shaped bend. This bend should be a rounded double bend. Tweezers that have jaws which are rounded inside can be used to form this double bend.

View C, Figure 2 shows another pattern that can be used for shaping the outside coil of a flat hairspring when circling the regulator sweep. This pattern allows for two dog-leg bends on the outside coil of the hairspring, one at the stud and another just beyond the regulator sweep. This is a more modern approach to shaping the outside coil of a flat hairspring.

Circling the Regulator Sweep of a Flat Hairspring

Figure 3 shows a flat hairspring after the regulator sweep has been circled and centered between the regulator pins. Note that when the regulator is set on center and at the fast and slow positions, the hairspring is still centered between the regulator pin and key. Anywhere between the slow and fast positions, the hairspring should be centered between the pin and key. The lip on the bottom of the regulator key has been removed in the illustration in order to show the space between the key and the pin.

Figure 4 shows the procedure used for circling the regulator sweep of a flat hairspring. This operation is started with the regulator set in the slow position as shown in View A. Note that in this position of the regulator, the hairspring is resting against the regulator pin. To correct this condition, the outside coil is pulled outward near the stud to center the hairspring between the key and the regulator pin.

View B, Figure 4 shows the regulator after it has been advanced to position "a." In this position, the hairspring is resting against the regulator key. To correct this condition, the regulator is backed up to position "b," then the outside coil is pushed in against the regulator pin to bend the coil inward so it will be centered between the key and the pin when the regulator is returned to position "a."

View C, Figure 4 shows the next step in circling the regulator sweep. The regulator is now advanced toward the fast side to position "a." In this position, the outside coil is resting on the regulator pin. To correct this condition, the regulator is backed up to position "b" and the coil is pulled outward against the regulator key to bend the coil outward so it will be centered between the key and the pin when the regulator is returned to position "a."

View D, Figure 4 shows how the regulator sweep is checked to make sure that it is centered between the key and the pin at all positions of the regulator from the slow to the fast positions. A good final test of the regulator sweep circling is to move the regulator from slow to fast as the hairspring is observed. There must not be any movement of the hairspring as the regulator is moved through its complete range. If there is any movement, the regulator sweep must be re-adjusted. After the regulator sweep has been formed, the hairspring is centered on the balance cock without disturbing the regulator sweep.

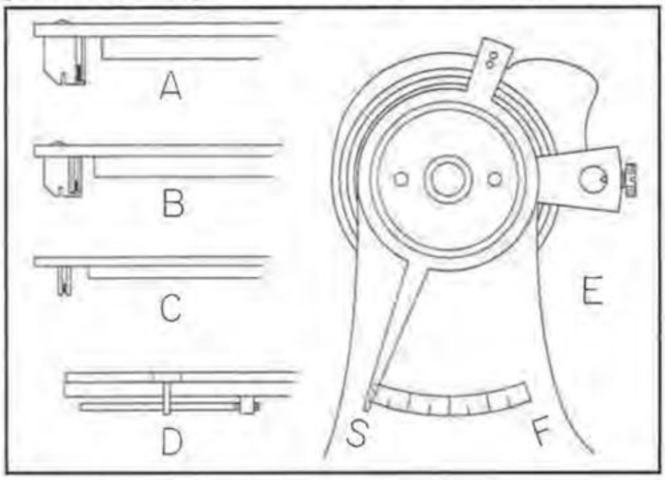

Figure 1.

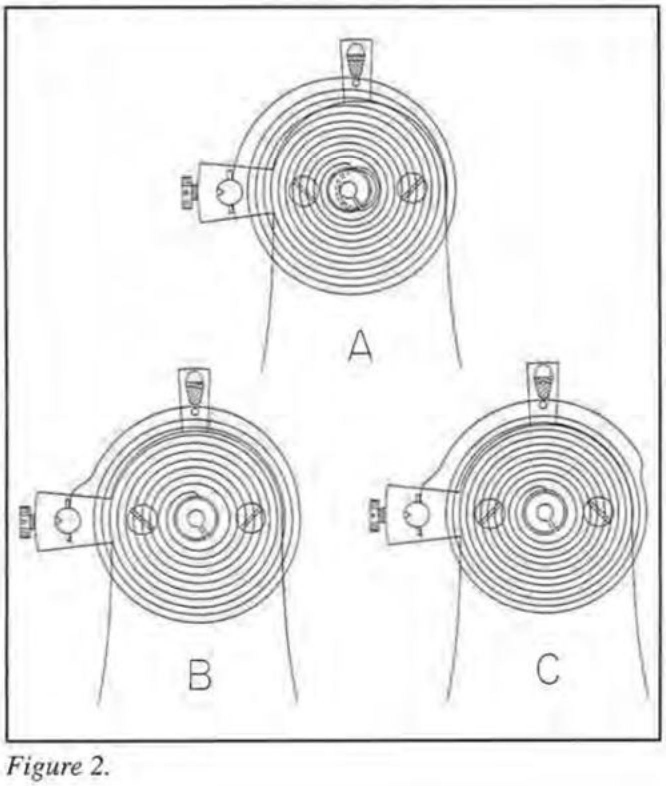

Figure 2.

Centering the Hairspring on the Balance Cock

Figure 5 shows a flat hairspring with two off-center, out-of-true conditions. View A shows a condition where the hairspring collet is off-center with the hole jewel in a direction away from the hairspring stud. The error is on the outside coil just outside the end of the regulator sweep. (See arrow, Figure 5.) This illustration shows the regulator set at the end of the regulator scale at the fast side. To center the collet with the hole jewel, the outside coil is corrected at the arrow with a pair of overcoiling tweezers or with tweezers which have rounded jaws. The outside coil is bent so its radius is decreased at the point where the arrow is located. This bend should be a very gradual bend, not sharp. The bend should be almost invisible, just enough to center the collet with the balance hole jewel. Note: It is very important that the

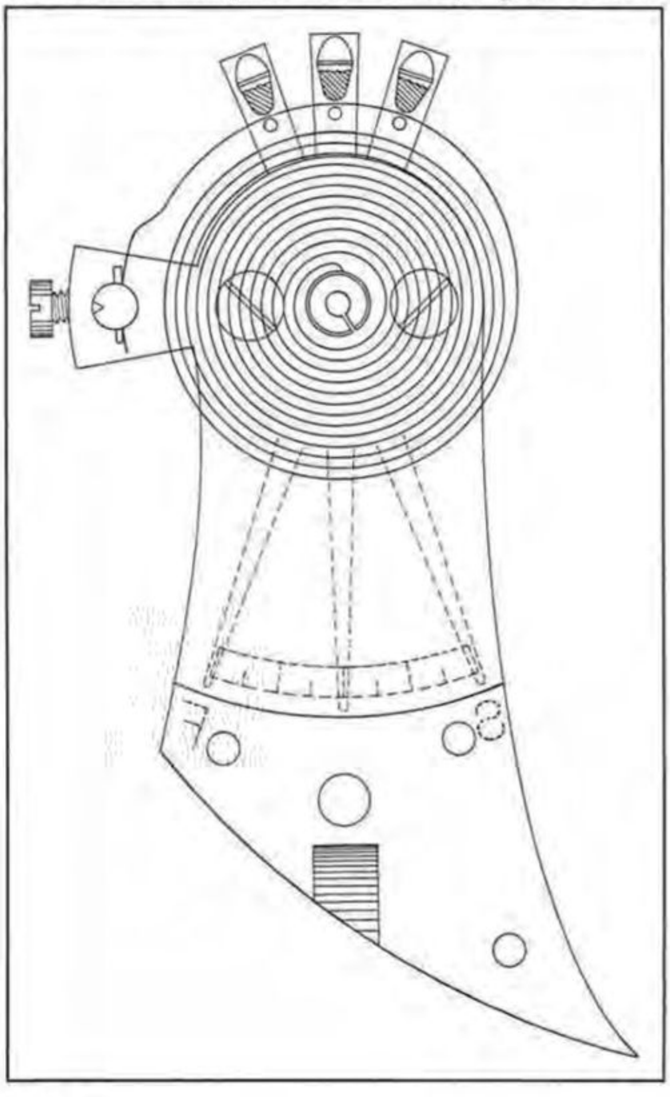

Figure 3.

hairspring has been trued on the collet before trying to center the collet with the jewel.

View B, Figure 5 shows another off-center condition. In this example, the hairspring and collet are off-center in a direction away from the regulator pins. The position of the bend is at the arrow. This bend can be corrected with overcoiling tweezers by reversing the tweezers on the bend so the concave jaw of the tweezers is on the outside of the coil and the convex jaw of the tweezers is on the inside of the coil over the bend. (See inset "a" in View B.) The bending should be kept to a minimum, just enough to center the collet with the jewel. This correction can also be made with a pair of round-jawed tweezers to hold the spring next to the bend while a needle is used to manipulate the coil of the hairspring.

Circling the Regulator Sweep of an Overcoiled Hairspring

Figure 6 shows the circling of the regulator sweep of an overcoiled hairspring. The circling is done in the same manner as for a flat hairspring. There is one difference between the two operations. The difference is that the stud's position on an overcoiled hairspring is usually the same distance from the center as the regulator pins are which makes it unnecessary to make a dog-leg bend at the stud.

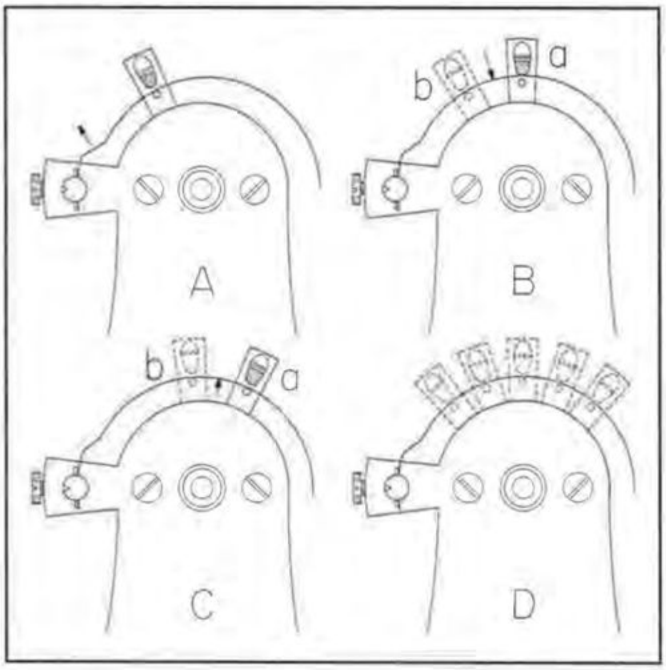

Figure 4.

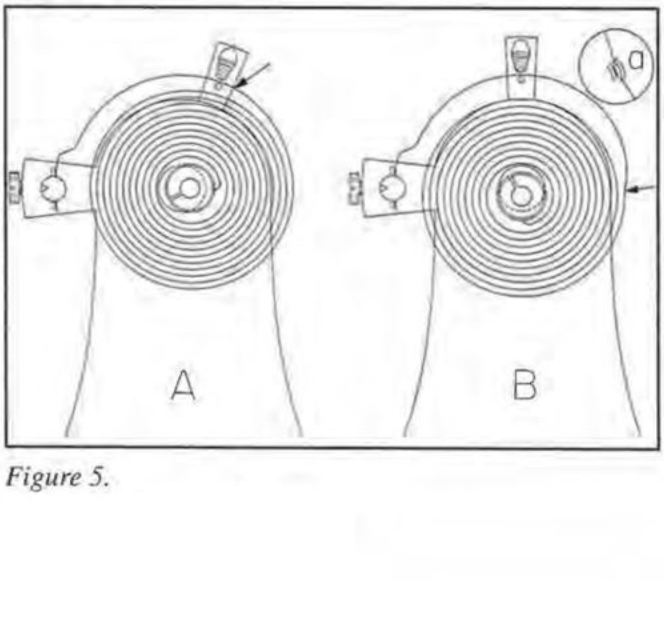

Figure 5.

Centering an Elgin Overcoiled Hairspring to the Balance Cock

Figure 7 shows how an Elgin overcoiled hairspring is centered to the balance cock. Since the Elgin overcoil is of the double quadrant type, these same procedures can be used on any double quadrant type of overcoil.

View A, Figure 7 shows a hairspring and collet that is off-center in a direction which is toward the straight part of the overcoil. The error is in the second bend which joins the regulator sweep. This is shown by an arrow. The second bend has a radius that is too long, and it must be shortened. This can be done with the overcoiling tweezers as shown in the inset in View A. By squeezing the tweezers, the bend is closed up more which will shift the hairspring and its collet to a centered position over the hole jewel. This operation can be done by holding the hairspring close to the bend with rounded-jaw tweezers and using a needle to manipulate the hairspring to center it.

View B, Figure 7 shows another off-center condition in an Elgin hairspring. In this case, the hairspring and collet are off-center in a direction away from the regulator pins. This condition is caused by the straight part of the overcoil being too long. The reason for this is that there is a sway in the straight part of the

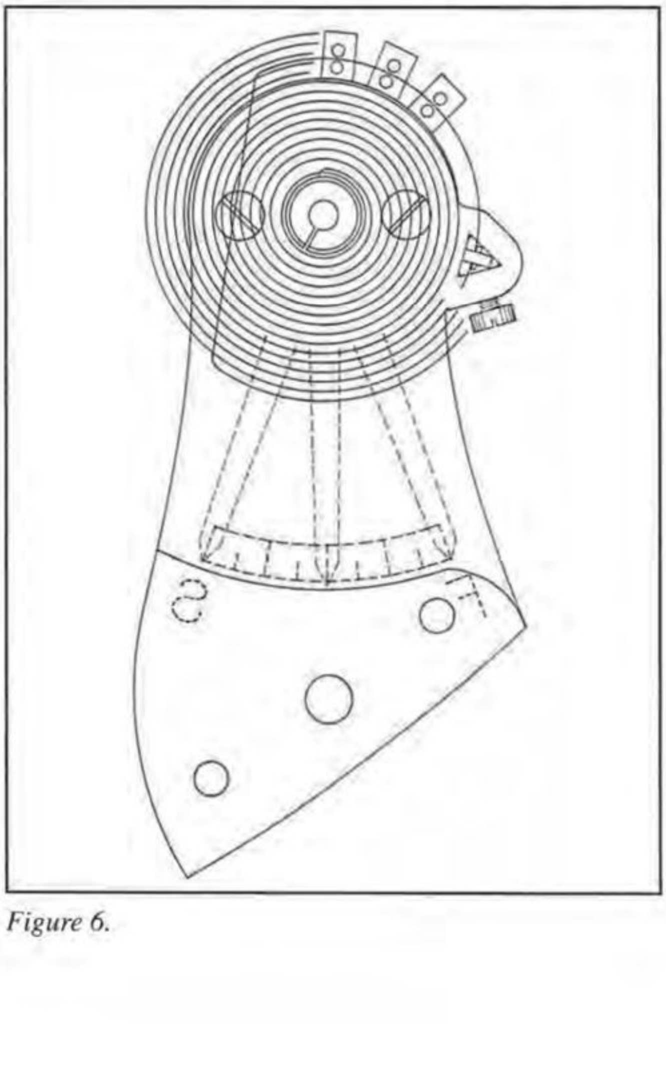

Figure 6.

overcoil. The reverse of this would be a hump in the straight part of the overcoil causing the straight section to be too short. To correct the condition in View B, Figure 7, the sway is removed making this section straight which will shift the hairspring and collet to center.

Figure 8 shows two other examples of Elgin overcoils that are off-center with the hole jewel. View A shows a condition where the hairspring and collet are off-center in a direction which is opposite the straight section of the overcoil. The error is in the first bend of the overcoil as the overcoil starts across the hairspring. This position is shown by the arrow. The radius of the bend is too long. This condition causes the straight section of the overcoil to be too far away from the center of the collet. The correction is to shorten the radius of the bend which will shift the whole body of the hairspring and its collet toward the straight section of the overcoil, bringing the collet back on center with the hole jewel. This correction can be done very nicely with the overcoiling tweezers, or it can be done with the rounded-jaw tweezers and a needle.

View B, Figure 8 shows the other example of an off-center Elgin hairspring. In this case, we have the opposite condition. The hairspring and collet are off-center in a direction toward the straight section of the overcoil. This places the straight section too close to the center of the hairspring collet. This condition is caused by the shortened radius of the first bend. (See arrow, Figure 8.) The correction would be to lengthen the radius of the bend which would shift the body of the hairspring and collet back

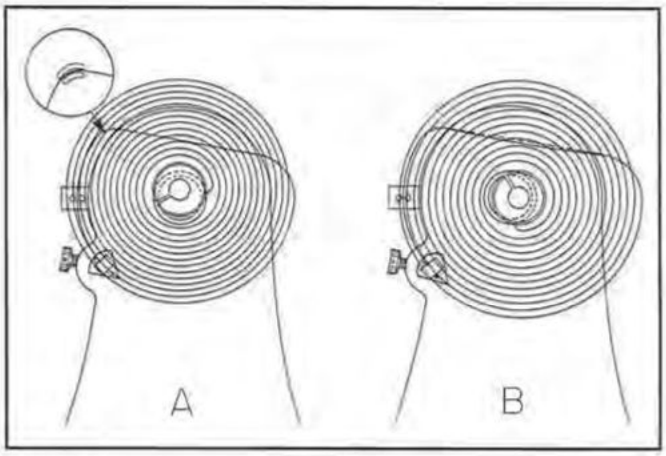

Figure 7.

on center with the hole jewel. This manipulation can be done with the overcoiling tweezers by placing the concave jaw on the inside of the bend and the convex jaw on the outside of the curve. The tweezers are squeezed just enough to correct the radius of the bend and center the collet. The bend can also be corrected with the rounded-jaw tweezers and a needle. When this bend is manipulated, the overcoil does not move; only the body of the spring moves in relation to the overcoil. When the second bend is manipulated, the straight section of the overcoil moves with the body of the hairspring.

View C shows a correctly shaped Elgin overcoil. The straight section of the overcoil encloses the first three coils from the collet and the regulator sweep goes between the second and third coils from the outside of the hairspring. These conditions may vary slightly from watch model to watch model.

Centering Hairsprings with Circular-Style Overcoils

Figure 9 shows three examples of off-center hairsprings that have circular-style overcoils. View A shows a condition where the hairspring and collet are off-center in a direction away from the hairspring stud. This condition is caused by a bend in the

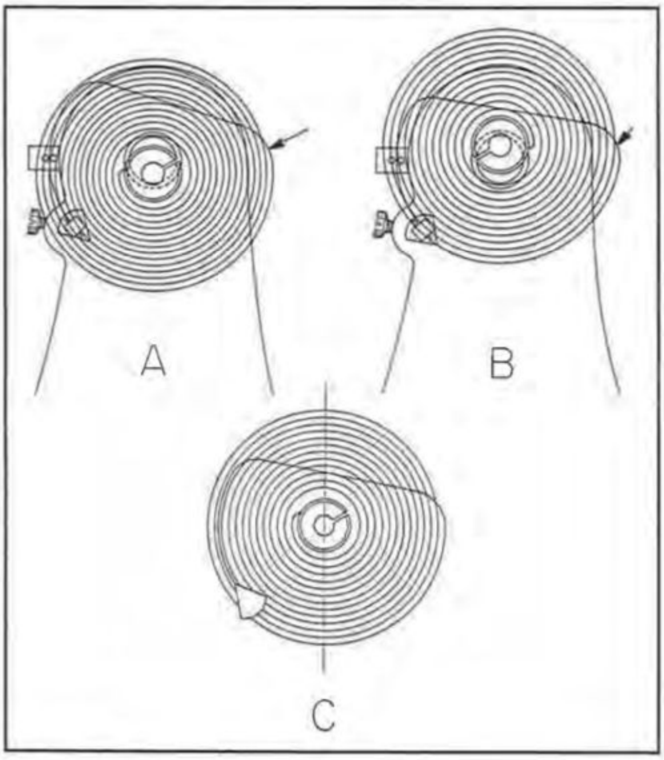

Figure 8.

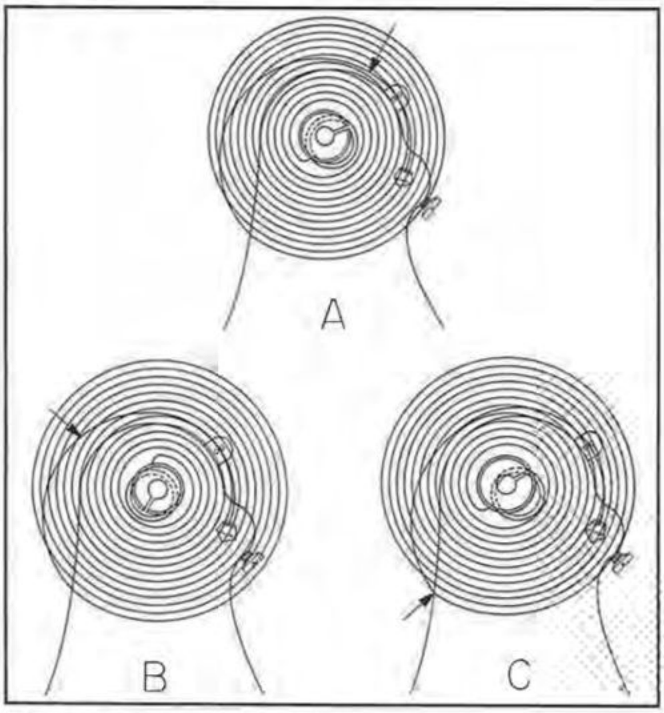

Figure 9.

overcoil at the arrow in the illustration. The overcoil at this point is too flat or the radius of the curve is too long. The correction is to shorten the radius of the overcoil at this point which will shift the spring and collet back on center. This manipulation can be done with large overcoiling tweezers or with rounded-jaw tweezers and a needle. Care must be used to avoid making kinks in the overcoil while correcting the condition.

View B, Figure 9 shows another off-center condition. In this example, the hairspring and collet are off-center in a direction toward the regulator pins. This condition is caused by a bend in the overcoil at the arrow. The overcoil at this point has a radius that is too short. When the radius of the overcoil is made longer, the hairspring and collet will shift back on center.

View C, Figure 9 shows the third example of an off-center hairspring which has a circular overcoil. In this example, the hairspring and collet are off-center in a direction away from the stud. This condition places the first part of the overcoil too close to the hairspring collet. This indicates that the bend is at a point where the overcoil starts across the body of the hairspring as shown by the arrow. This bend is too sharp, causing the overcoil to start across the body of the hairspring too suddenly. The correction is to round out the bend giving it a longer radius. This will cause the hairspring to shift back to center and, at the sane time, the collet will be moved away from the overcoil. When the conditions are the exact opposite to these examples, the corrections will be just the opposite.

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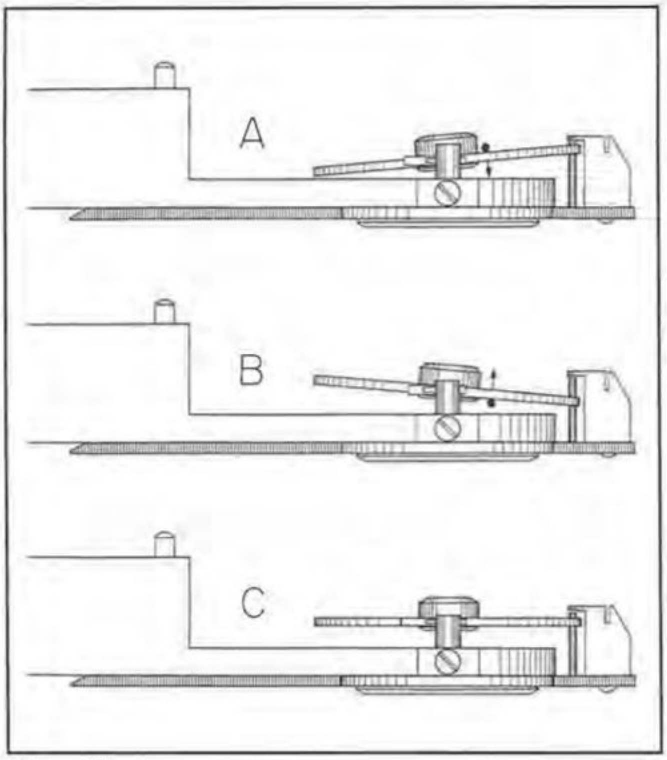

Figure 1.

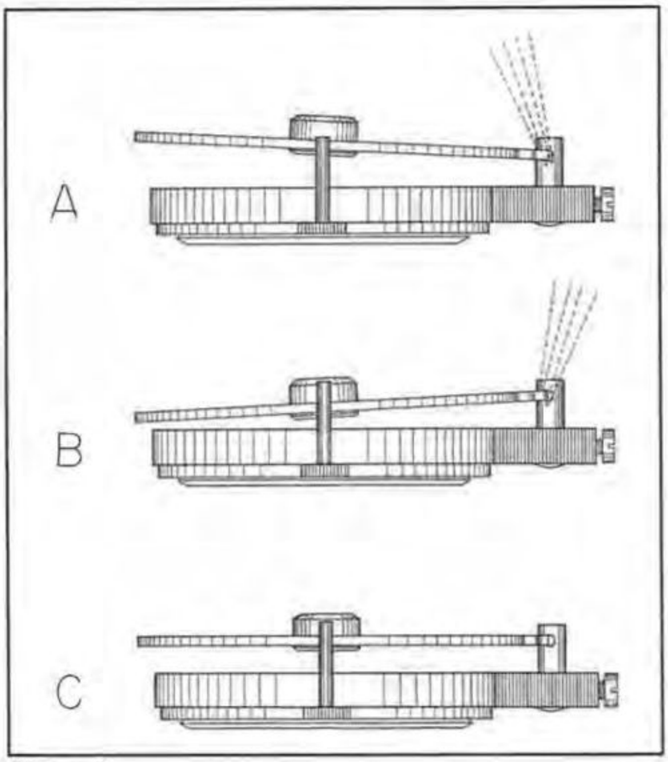

Figure 2.

TECHNICALLY WATCHES

ANTIQUE WATCH RESTORATION, PART CXXVIII

TRUING HAIRSPRINGS TO THE BALANCE COCK AND IN THE WATCH

By Archie B. Perkins, CMW, FNAWCC, FBHI

An acceptable procedure for truing hairsprings to a watch is to first true the hairspring to the balance cock and regulator pins to correct any major conditions, then to finally true the hairspring in the watch to correct any minor conditions. After the regulator sweep has been formed and the spring centered with the hole jewel in the balance cock, the hairspring is leveled to the balance cock. After this, we must recheck the regulator sweep and the centering of the hairspring to make sure that these correct conditions were not disturbed during the leveling process.

Truing Flat Hairsprings in the Flat

Figure 1, Views A and B show a flat hairspring which is out of true in the flat 90° from the hairspring stud. View A shows a condition where the hairspring is almost touching the underside of the balance cock on one side of the collet and almost touching the lip on the regulator key on the other side of the collet. This condition is caused by an edgewise bend in the outside coil of the hairspring at the stud. The correction for this condition is to place a needle or fine tweezers jaw on the edge of the outside coil near the stud as shown and to pull down on the coil in the direction of the arrow. This is done until the hairspring is level with the underside of the balance cock.

View B, Figure 1 shows a flat hairspring that is out of flat in the opposite direction to the one shown in View A. To correct this hairspring, the needle is placed on the underside of the outside coil next to the stud, as shown, and the coil is lifted in the direction of the arrow to level the hairspring to the balance cock.

View C, Figure 1 shows the corrected hairspring. The hairspring should be viewed from the regulator pin side as well as from the stud side to make sure that the hairspring is level with the balance cock.

Figure 2, Views A and B, show a flat hairspring which is out of flat 180° from the stud. View A shows a condition where the spring is too far from the underside of the balance cock opposite the stud. The spring would be too low opposite the stud when the balance cock is turned over in its normal operating position. This condition is caused by a twist in the outside coil near the stud. The twist in the coil is removed with the tweezers by pinching the coil near the stud as shown in broken line. The tweezers are used at the proper angle so when they are squeezed slightly, the twist will be removed and the spring leveled.

View B, Figure 2 shows an out-of-flat condition that is just the opposite to the condition that is shown in View A. The hairspring is high opposite the stud when the balance cock is turned over in its normal operating position. This out-of-flat condition is corrected with the tweezers by grasping the outside coil near the stud as shown. The tweezers are squeezed to remove the twist in the coil to level the hairspring.

View C, Figure 2 shows the hairspring after it has been leveled to the balance cock. After a hairspring has been leveled, it must be checked to make sure that its centering and regulator sweep have not been disturbed.

Figure 3, View A shows a flat hairspring in the watch that is cupped down. Note that the outside coil of the hairspring is level with the balance wheel arm but is lower than the pinning at the collet. This condition is caused by the stud being too low in its hole in the balance cock. To correct this condition, the stud is raised in the balance cock.

View B, Figure 3 shows a flat hairspring that is uniformly cupped up in the watch. This condition is the opposite to that of View A. This is corrected by lowering the hairspring stud. These conditions are greatly exaggerated in the illustrations. Ordinarily the spring would not show this much of a cupped condition and would not require the stud to be raised or lowered very much.

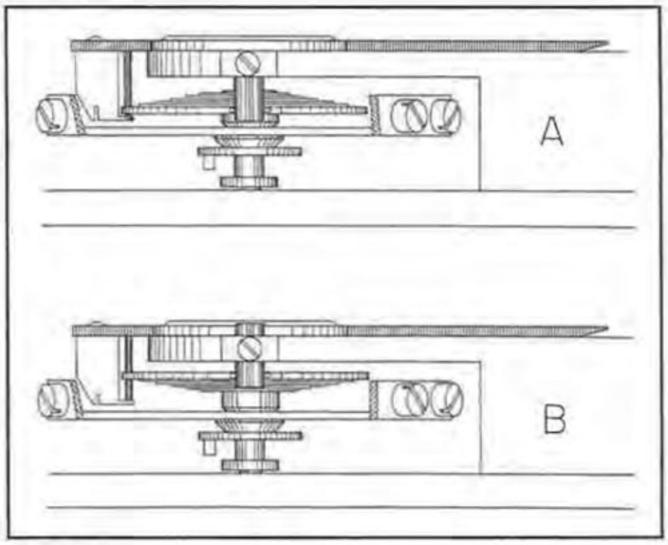

Figure 3.

Checking the Overcoiled Hairspring in the Flat

Figure 4, View A shows an overcoiled hairspring fastened to the balance cock by its stud. The spring is being viewed with the regulator pins on center and the stud is to the right of center. In this view, the hairspring is level. The overcoil is level with the balance cock and the body of the spring is level with the overcoil. This is the way the hairspring should appear for it to function correctly.

View B, Figure 4 shows another view of the hairspring. In this illustration, the stud is on center and the regulator pins are to the left of center. The spring still shows to be true in the flat. Hairsprings should always be checked in these two directions when truing them in the flat. Note: Although the hairspring shows to be true on the balance cock, when it is placed in the watch, it could be cupped up or down. This can be caused by the height of the overcoil or the height of the stud.

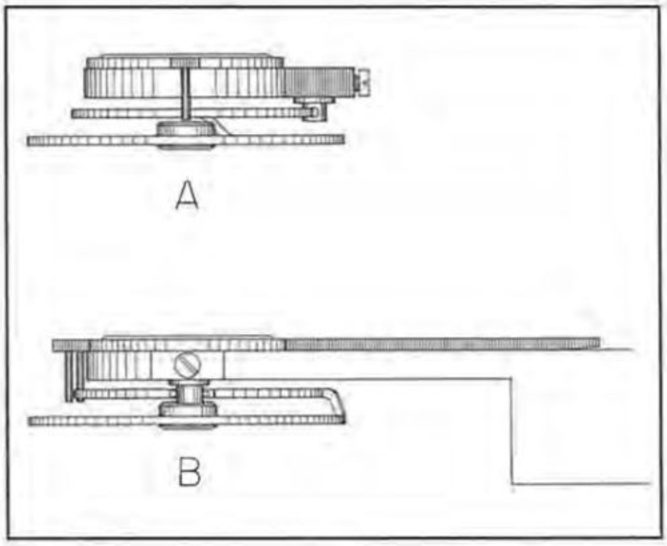

Figure 4.

Truing the Overcoiled Hairspring in the Flat

Figure 5 shows one of the first steps used to true an overcoiled hairspring to the balance cock. View A, Figure 5 shows an overcoiled hairspring attached to the

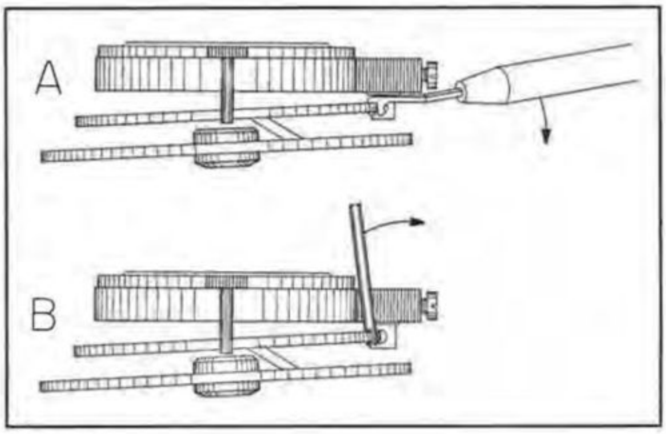

Figure 5.

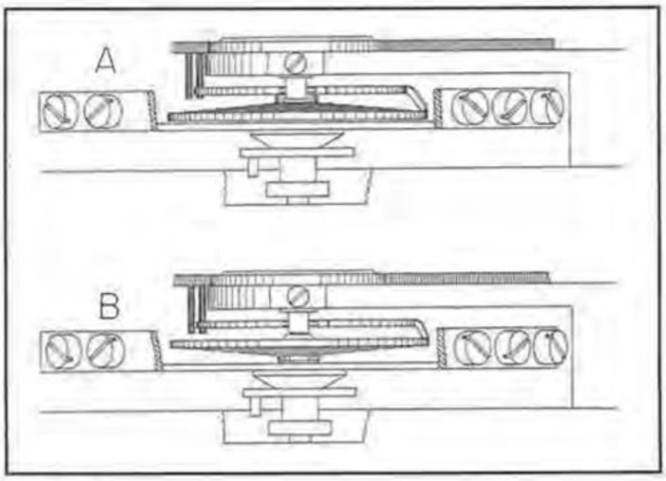

Figure 6.

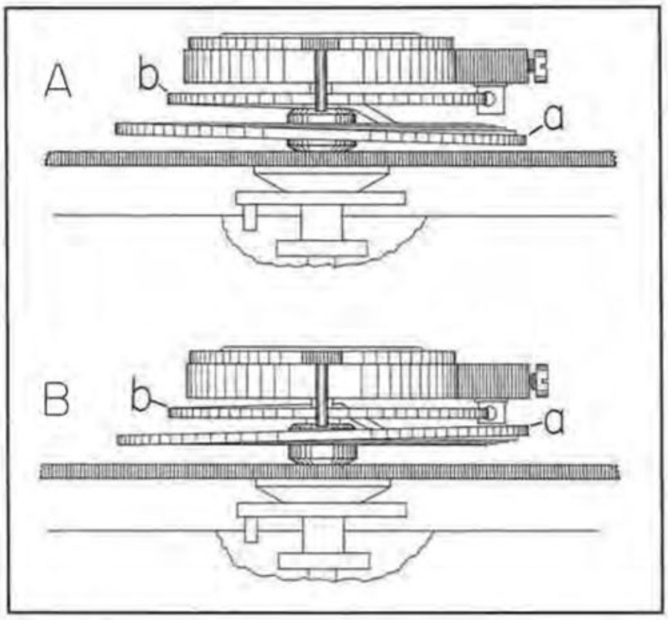

Figure 7.

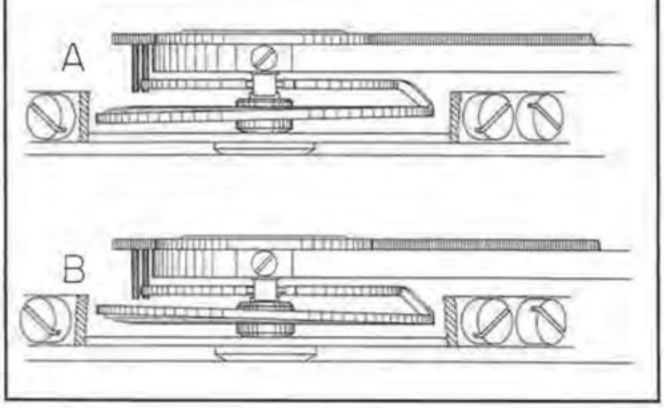

Figure 8.

balance cock by its stud. The hairspring is not level with the balance cock although the overcoil is level with the body of the hairspring. The out-of-flat condition of the hairspring in relation to the balance cock is caused by a twist in the overcoil at the stud. Usually a pair of tweezers are used to remove the twist in the coil. Sometimes it is difficult to get the points of the tweezers into proper position to manipulate the hairspring. This is because of the close space between the edge of the balance cock and the overcoil near the stud. The hairspring can be removed from the balance cock to correct the condition. Another method that can be used to remove the twist in the overcoil is by the use of a hairspring leveler as shown in View A, Figure 5. Years ago, sets of these levelers were sold by watch material suppliers. When using a leveler, the slot in the tool must not be so narrow that it gets stuck on the coil of the hairspring. If this happens, the hairspring could become damaged trying to remove the leveler.

View B, Figure 5 shows a leveler that can easily be made by the watchmaker. This leveler is made from a piece of brass or nickel silver wire. A slot is sawed in the center of the end of the wire with a circle saw. A set of these levelers can be made by using different thicknesses of circle saws for cutting the slots in different diameter wires. When removing the twist in the overcoil that is shown, the levelers are moved in the direction of the arrows. If the hairspring should be too high opposite the stud, the levelers would be moved in the opposite direction.

Overcoil Too High or Too Low

Figure 6, View A shows an overcoil hairspring in the watch. The overcoil is level with the balance cock and is about the correct distance from the balance cock. The body of the hairspring is cupped down, although the outside coil is level with the overcoil. The hairspring stud cannot be raised enough to remove the cupped condition of the hairspring. This indicates that the overcoil is too high or too far from the body of the hairspring. In this case, the high overcoil is pressing the body of the hairspring downward causing it to be cupped downward. The only solution to the problem is to lower the overcoil making it closer to the body of the hairspring. This is done by changing the height of the rise bend whether it is a gradual rise or a knee bend.

View B, Figure 6 shows an overcoil in the watch which is level except the body of the hairspring is cupped upward. This indicates that the overcoil is too low or too close to the body of the hairspring. This causes the overcoil to pull upward on the body of the hairspring causing it to be cupped upward. The stud cannot be lowered enough to level the spring. Therefore, the only solution to the problem is to raise the overcoil and make it farther from the body of the hairspring.

Leveling the Body of the Overcoiled Hairspring

Figure 7 shows an overcoiled hairspring in the watch.

The overcoil is level with the balance cock but the body of the hairspring is out of flat under the hairspring stud.

View A shows a condition where the body of the spring is low at point "a" under the stud. This condition indicates that there is a twist in the overcoil at point "b" which is opposite the stud. To correct this condition, the overcoil is manipulated at point "b" with the tweezers to raise the low point so the body of the hairspring is level.

View B, Figure 7 shows an overcoiled hairspring that has a condition that is opposite to the condition shown in the first example. In this latter case, the body of the hairspring is high under the hairspring stud at point "a." This condition indicates that the hairspring overcoil is twisted at point "b" but in the opposite direction to the twist in the first example. The twist is removed with the tweezers to lower the body of the hairspring at point "a" until the body is level. Note: When leveling a hairspring, the bend will be 180° from where the spring shows to be off the most. When centering a hairspring, the bend will be 90° from where the hairspring shows to be off the most.

Figure 8 shows two other out-of-flat conditions. View A shows a condition where the body of the hairspring is low at a point under the regulator pins. This condition is caused by a twist in the area of the rise bend. The exact point of manipulation would be 180° from where the spring shows to be off the most. The spring is manipulated to raise the low point so the body of the hairspring is level.

View B, Figure 8 shows an overcoiled hairspring with an out-of-flat body. The body is high under the regulator pins. This condition is caused by a twist in the outside coil in or near the rise bend. The exact point of the twist is located by determining the point where the spring is off the most and then going 180° from this point to locate the twist. The tweezers are used to remove the twist to level the body of the hairspring.

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